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National Air Quality and Emissions Trends Report, 1985

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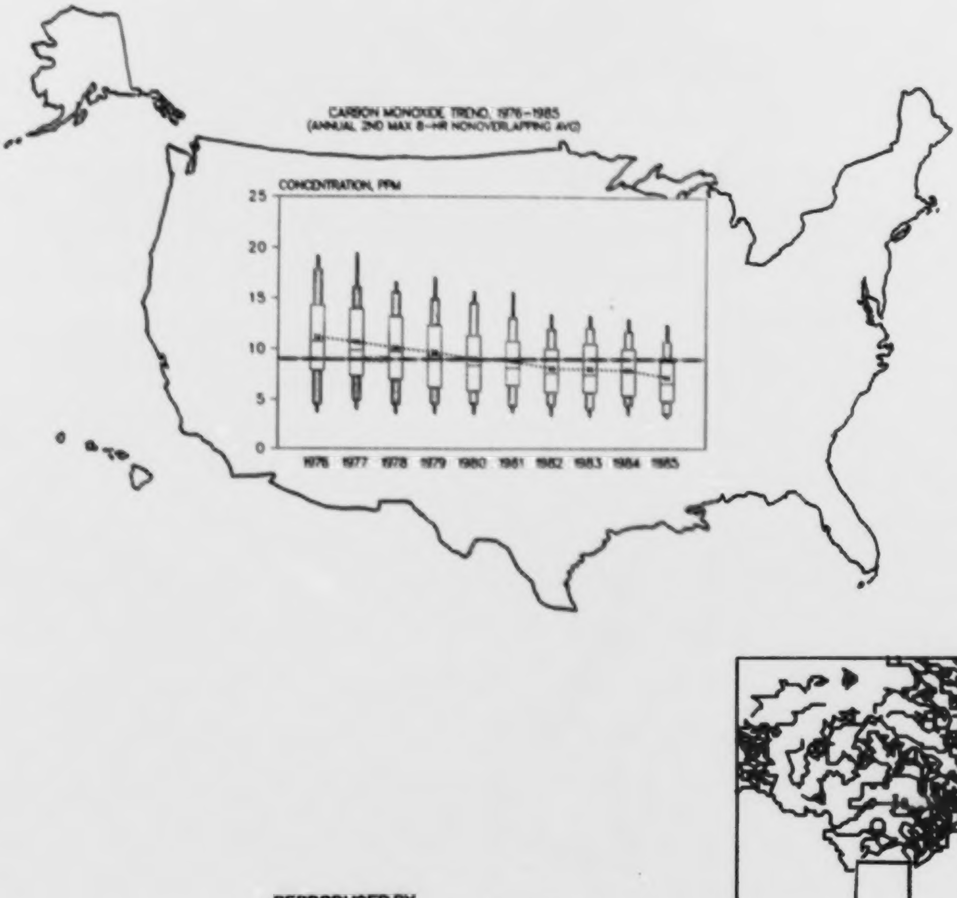
National Air Quality and Emissions Trends Report, 1985


CARBON MONOXIDE TREND, 1976-1985
(ANNUAL 2ND MAX 8-HR NONOVERLAPPING AVG)
CONCENTRATION, PPM
25
20
15
10
5
0
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985

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16. ABSTRACT

This report presents national and regional trends in air quality from 1976 through 1985 for total suspended particulate, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone and lead. Air pollution trends were also examined for the 5-year period (1981-85) to take advantage of the larger number of sites and the fact that the data from the post-1980 period should be of the highest quality. Both national and regional trends in each of the major pollutants are examined. National air quality trends are also presented for both the National Air Monitoring Sites (NAMS) and other site categories. In addition to ambient air quality, trends are also presented for annual nationwide emissions. These emissions are estimated using the best available engineering calculations; the ambient levels presented are averages of direct measurements.

This report also includes a section, Air Quality Levels in Metropolitan Statistical Areas (MSA's). Its purpose is to provide interested members of the air pollution control community, the private sector and the general public with greatly simplified air pollution information. Air quality statistics are presented for each of the pollutants for all SMSA's with populations exceeding 500,000 for the years 1983, 1984 and 1985.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Trends Emission Trends Carbon Monoxide Nitrogen Dioxide Ozone Sulfur Dioxide Total Suspended Particulates Lead	Air Pollution Metropolitan Statistical Area (MSA) Air Quality Standards National Air Monitoring Stations (NAMS)		

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Monitoring and Data
Analysis Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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PREFACE

This is the thirteenth annual report of air pollution trends issued by the Monitoring and Data Analysis Division of the U. S. Environmental Protection Agency. The report is directed toward both the technical air pollution audience and the interested general public. The Division solicits comments on this report and welcomes suggestions on our trend techniques, interpretations, conclusions, and methods of presentation. Please forward any response to William F. Hunt, Jr., (MD-14) U. S. Environmental Protection Agency, Monitoring and Data Analysis Division, Research Triangle Park, N. C. 27711.

The Monitoring and Data Analysis Division would like to acknowledge William F. Hunt, Jr., for the overall management, coordination, and direction given in assembling this report. Special mention should also be given to Helen Hinton and Cathy Coats for typing the report.

The following people are recognized for their contributions to each of the sections of the report as principal authors:

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Section 3 - Thomas C. Curran, Robert B. Faoro, Neil H. Frank, and Warren P. Freas
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Also deserving special thanks are Bob Mersch, PEI, for preparing the computer graphics, Chuck Mann, Jake Summers and Susan Kimbrough for the emission trend analyses, George Duggan for the population exposure estimates, and David Henderson and Coe Owen of EPA Region IX for providing us with their computer software to generate the air quality maps of the United States used in this report.

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NATIONAL AIR QUALITY AND EMISSIONS TRENDS REPORT, 1985

EXECUTIVE SUMMARY

NATIONAL AIR QUALITY AND EMISSIONS TRENDS REPORT, 1985

1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

While considerable progress has been made controlling air pollution, it still remains a serious public health problem. In order to protect the public health and welfare, the U.S. Environmental Protection Agency (EPA) has promulgated National Ambient Air Quality Standards (NAAQS). Primary standards protect the public health, while secondary standards protect the public welfare, as measured by the effects of air pollution on vegetation, materials and visibility. This report will focus on comparisons to the primary standards to examine both changes in air pollution levels over time, as well as current air pollution status.

In 1985, 76.4 million people were living in counties with measured air quality levels that violated the NAAQS for ozone (O_3) (Figure 1-1). This compares with 47.8 million people for total suspended particulate (TSP), 39.6 million people for carbon monoxide (CO), 7.5 million people for nitrogen dioxide (NO_2), 4.5 million people for lead (Pb) and 2.2 million people for sulfur dioxide (SO_2). While millions of people continue to breathe air that is in violation of the NAAQS, considerable progress is being made in reducing air pollution levels.

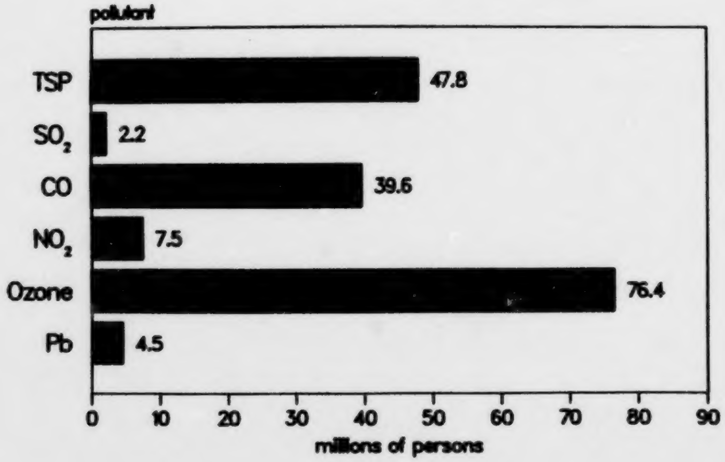

Figure 1-1. Number of persons living in counties with air quality levels above the primary National Ambient Air Quality Standards in 1985 (Based on 1980 population data).

Nationally, long-term 10-year (1976 through 1985) improvements can be seen for TSP, SO_2, CO, NO_2, O_3, and Pb. Similar improvements have been documented in earlier air quality trends reports,[1-12] issued by EPA. The trend in O_3 is complicated by a major drop in measured concentration levels which occurred between 1978 and 1979, largely due to a change in the O_3 measurement calibration procedure.[13] Therefore, special attention is given to the period after 1978, because the change in the calibration procedure is not an influence during this time.

The 10-year trend (1976-1985) is complemented with a more recent 5-year trend (1981-1985). The 5-year trend was introduced in last year's[12] report to increase the number of sites available for trend analysis. Emphasis is placed on the post-1980 period to take advantage of the larger number of sites and the fact that the data from the post-1980 period should be of the highest quality, with sites meeting uniform siting criteria and high standards of quality assurance. Nationally, improvements can be seen for all the pollutants during the 5-year period. Between 1984 and 1985, all of the pollutants declined with major decreases observed for both carbon monoxide, 10 percent, and lead, 32 percent.

The trends in ambient air quality, that follow, are presented as boxplots, which display the 5th, 10th, 25th, 50th (median), 75th, 90th and 95th percentiles of the data, as well as the composite average (Figure 1-2). The 5th, 10th and 25th percentiles depict the "cleaner" sites, while the 75th, 90th and 95th depict the "dirtier" sites and the median and average describe the "typical" sites. The use of the boxplots allow us to simultaneously compare trends in the "cleaner", "typical" and "dirtier" sites.

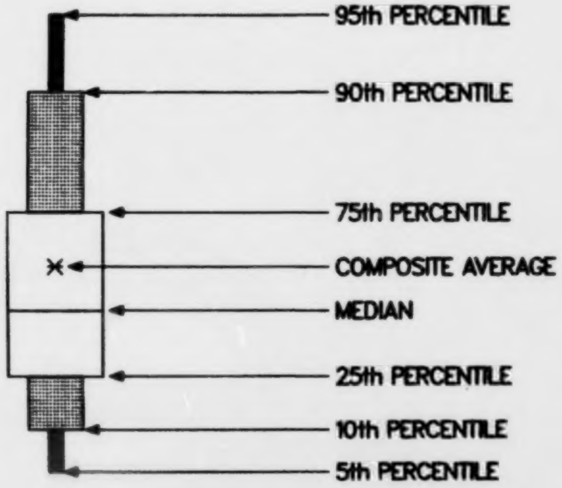

Figure 1-2. Illustrations of plotting conventions for boxplots.

All of the ambient air quality trend analyses are based on monitoring sites which recorded at least 8 of the 10 years of data in the period 1976 to 1985 or 4 out of 5 years in the period 1981 to 1985. Each year had to satisfy an annual data completeness criteria, which is discussed in Section 2.1, Data Base.

Finally, the Executive Summary also contains air quality maps of the United States to show at a glance how air quality varies among the 89 largest metropolitan statistical areas (MSA). In each map, a spike is plotted at the city location on the map surface. This represents the highest pollutant concentration, recorded in 1985, corresponding to the appropriate air quality standard. Each spike is projected onto a backdrop facilitating comparison with the level of the standard. This also provides an east-west profile of concentration variability throughout the country.

1.2 MAJOR FINDINGS

Total Suspended Particulate (TSP) - Annual average TSP levels, measured at 1400 sites, decreased 24 percent between 1976 and 1985 (Figure 1-3). This corresponds to a 24 percent decrease in estimated particulate emissions for the same period (Figure 1-4). EPA has found that the TSP data collected during the years 1979-1981 may be biased high due to the glass fiber filter used during these years, and that most of the large apparent 2-year decrease in pollutant concentrations between 1981 and 1982 can be attributed to a change in these filters.[11,14,15] For this reason, the portion of the Figure 1-3 graph corresponding to 1979-1981 is stippled, indicating the uncertainty associated with these data. As reported in last year's trends report,[12] there was a slight increase in particulate levels between 1983 and 1984 due to a return of rainfall to more normal levels and an increase in particulate emissions. Between 1984 and 1985, particulate levels declined 4 percent, while emissions declined 3 percent. An examination of regional trends patterns indicates decreases in TSP were evident in most Regions between 1984 and 1985. Two of the EPA Regions, Region V (the Great Lake States) and Region VI (the South Central States) were among the group of Regions showing the largest particulate air quality improvements and were also the only Regions experiencing increases in precipitation. Correspondingly, it is likely that some of these Regional improvements were due to 1985 being a wetter year. The most recent 1985 annual geometric mean TSP concentration is plotted for the 89 largest MSA(s) (Figure 1-5). The highest concentrations are generally found in the industrial Midwest and arid areas of the West. The east-west profile shows that levels above the current standard of 75 ug/m^3 can be found throughout the Nation.

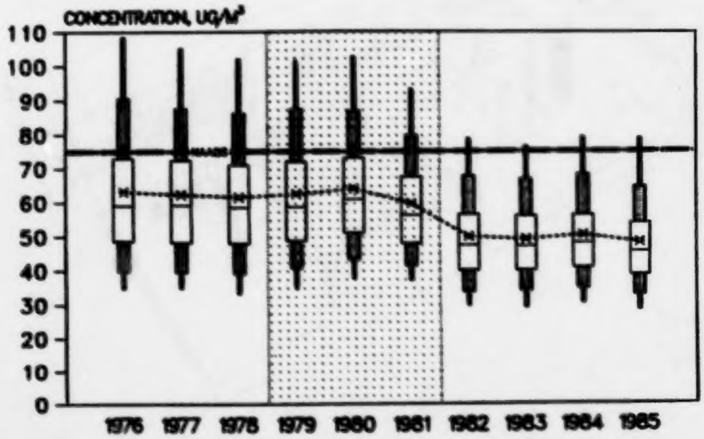

Figure 1-3. National boxplot trend in annual geometric mean TSP concentrations, 1976 - 1985.

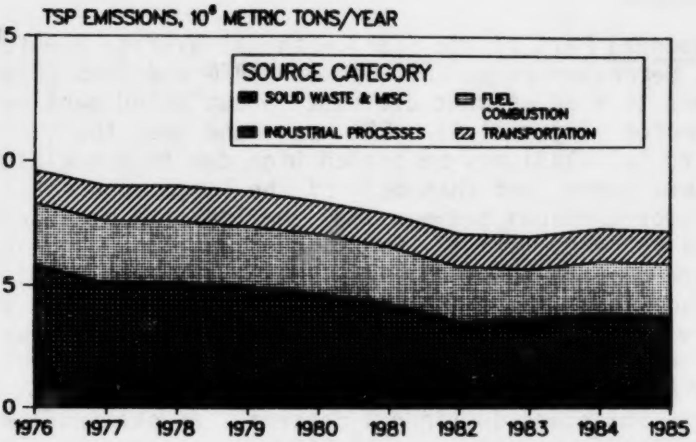

Figure 1-4. National trend in particulate emissions, 1976 - 1985.

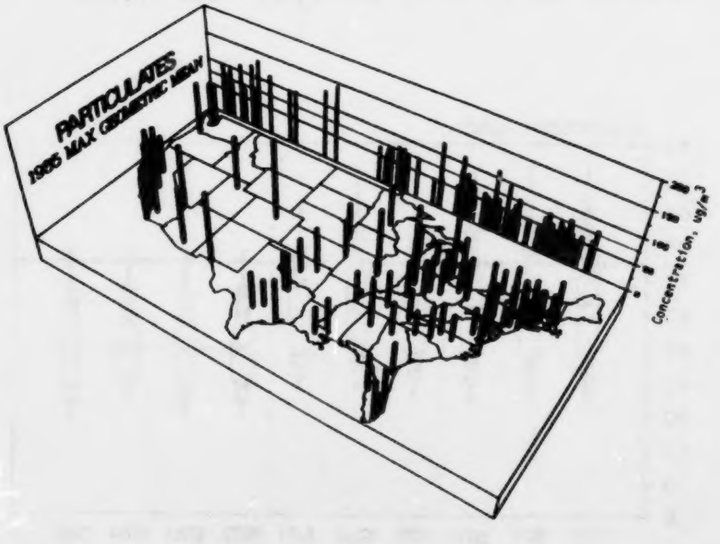
PARTICULATES
1985 MAX GEOMETRIC MEAN
Concentration, ug/m3

Figure 1-5. United States map of the highest annual geometric mean TSP concentration by MSA, 1985.

Sulfur Dioxide (SO_2) - Annual average SO_2 levels measured at 264 sites with continuous SO_2 monitors decreased 42 percent from 1976 to 1985 (Figure 1-6). A comparable decrease of 44 percent was observed in the trend in the composite average of the second maximum 24-hour averages (Figure 1-7). An even greater improvement was observed in the estimated number of exceedances of the 24-hour standard, which decreased 95 percent (Figure 1-8). Correspondingly, there was a 21 percent drop in sulfur oxide emissions (Figure 1-9). The difference between emissions and air quality can be attributed to several factors. SO_2 monitors are mostly urban population-oriented and as such do not monitor many of the major emitters which tend to be located in more rural areas. The residential and commercial areas, where most monitors are located, have shown sulfur oxide emission decreases comparable to SO_2 air quality improvement. Between 1984 and 1985, nationwide average SO_2 levels decreased 5 percent. The decrease in ambient levels correspond to a 3 percent decrease in sulfur oxide emissions. The most recent 1985 annual arithmetic mean SO_2 is plotted for the 89 largest MSA(s) (Figure 1-10). Among these large metropolitan areas, the higher concentrations are found in the heavily populated Midwest and Northeast. All urban areas have ambient air quality concentrations lower than the current annual standard of (.03 ppm) 80 ug/m^3. However, this map only represents areas with population greater than one half million, it does not reflect air quality in the vicinity of smelters or large power plants in rural areas, and it does not reflect violations of the 24-hour standard.

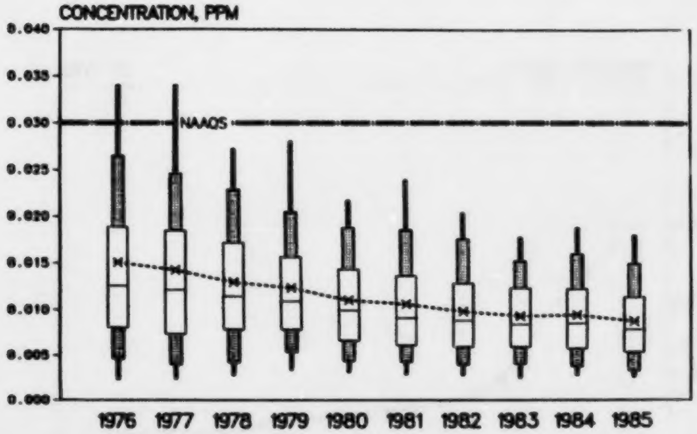

Figure 1-6. National boxplot trend in annual average SO_2 concentrations, 1976 - 1985.

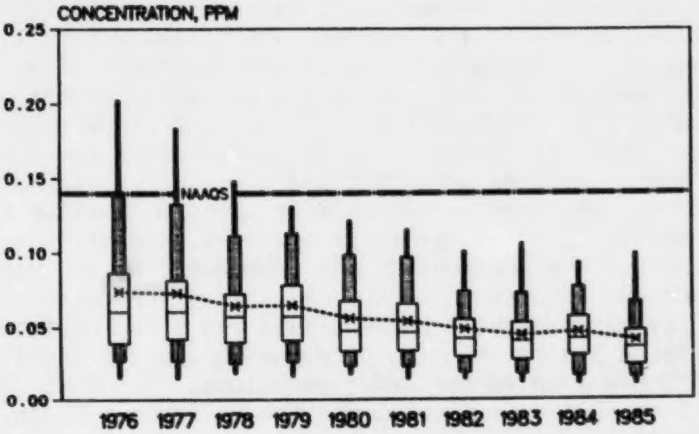

Figure 1-7. National boxplot trend in second highest 24-hour SO_2 concentrations, 1976 - 1985.

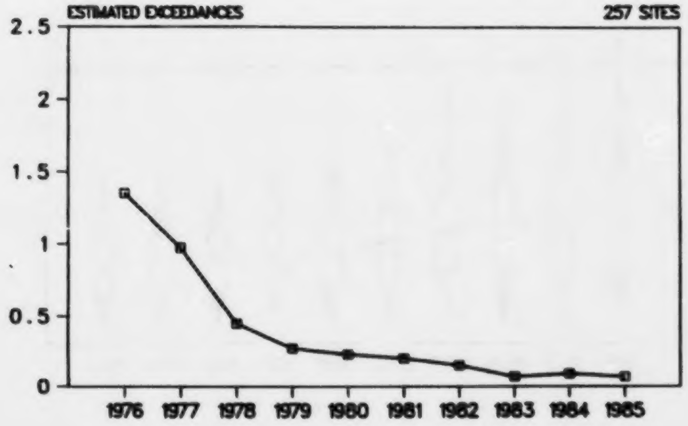

Figure 1-8. National trend in the composite average of the estimated number of exceedances of the 24-hour SO_2 NAAQS, 1976 - 1985.

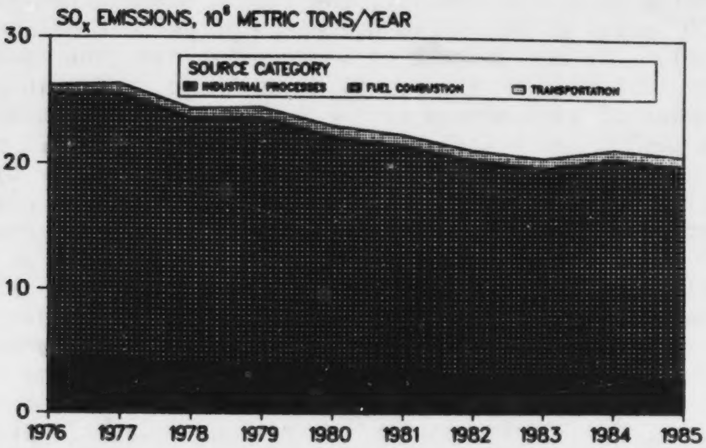

Figure 1-9. National trend in sulfur oxide emissions, 1976 - 1985.

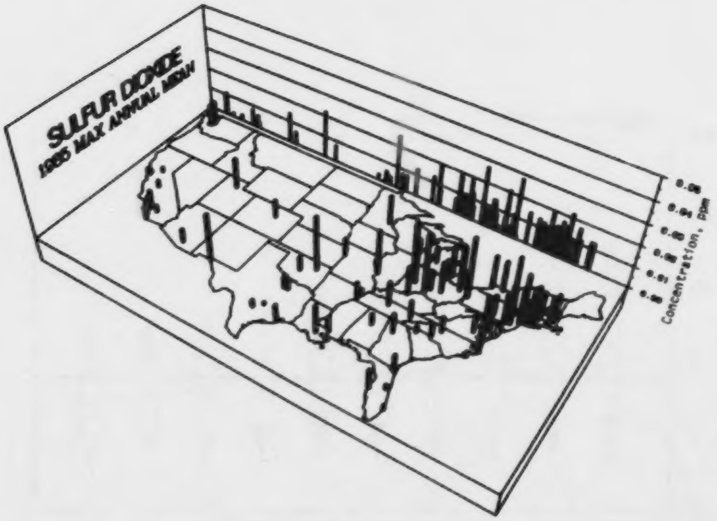
SULFUR DIOXIDE
1985 MAX ANNUAL MEAN
Concentration, ppm

Figure 1-10. United States map of the highest annual arithmetic mean SO_2 concentration by MSA, 1985.

Carbon Monoxide (CO) - Nationally, the second highest non-overlapping 8-hour average CO levels at 163 sites decreased 36 percent between 1976 and 1985 (Figure 1-11). The median rate of improvement has been about 5 percent per year, but the 1984-85 decrease was twice as large, about 10 percent. The estimated number of exceedances of the 8-hour NAAQS decreased 92 percent between 1976 and 1985 (Figure 1-12). CO emissions decreased 21 percent during the same period (Figure 1-13). Because CO monitors are typically located to identify potential problems, they are likely to be placed in traffic saturated areas that may not experience significant increases in vehicle miles of travel. As a result, the air quality levels at these locations generally improve at a rate faster than the nationwide reduction in emissions. Between 1984 and 1985, CO levels decreased 10 percent. This is probably due to the continuing reductions in CO emissions brought about by the Federal Motor Vehicle Control Program, the change in the vehicle mix and the possible influence of meteorological conditions in some geographic areas. The most recent 1985 highest second maximum nonoverlapping 8-hour average CO concentration is plotted for the 89 largest MSA(s) (Figure 1-14). The east-west profile indicates that many of these urban areas in all geographic regions have air quality at or exceeding the 9 ppm level of the standard.

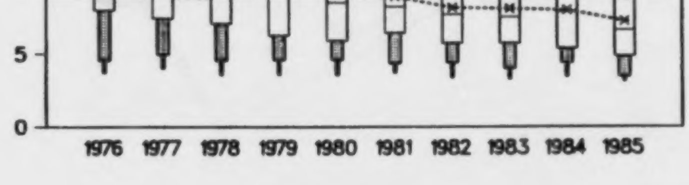

Figure 1-11. National boxplot trend in the second highest nonoverlapping 8-hour average CO concentrations, 1976 - 1985.

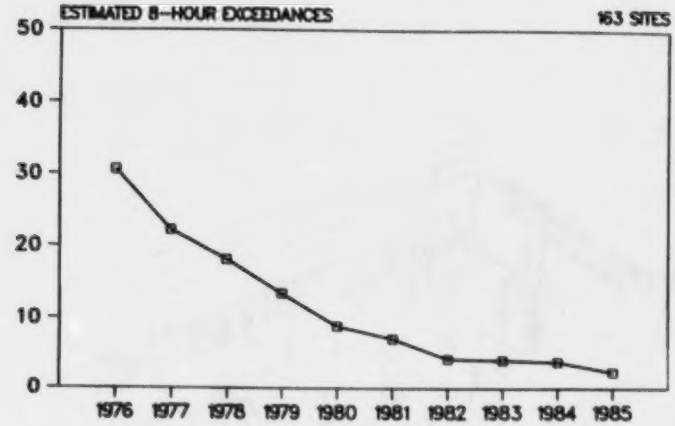

Figure 1-12. National trend in the composite average of the estimated number of exceedances of the 8-hour CO NAAQS, 1976 - 1985.

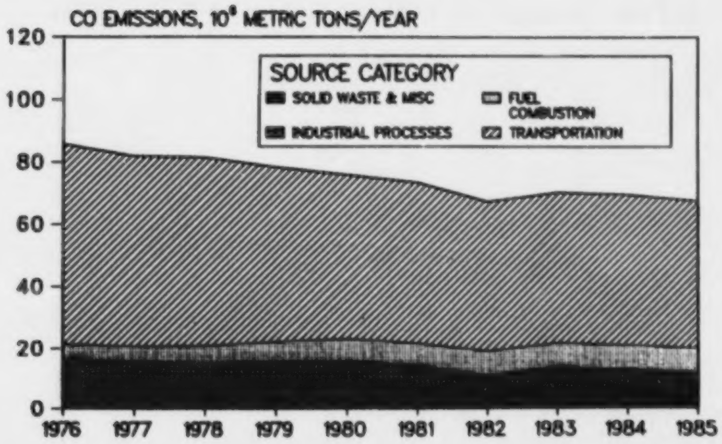

Figure 1-13. National trend in emissions of carbon monoxide, 1976 - 1985.

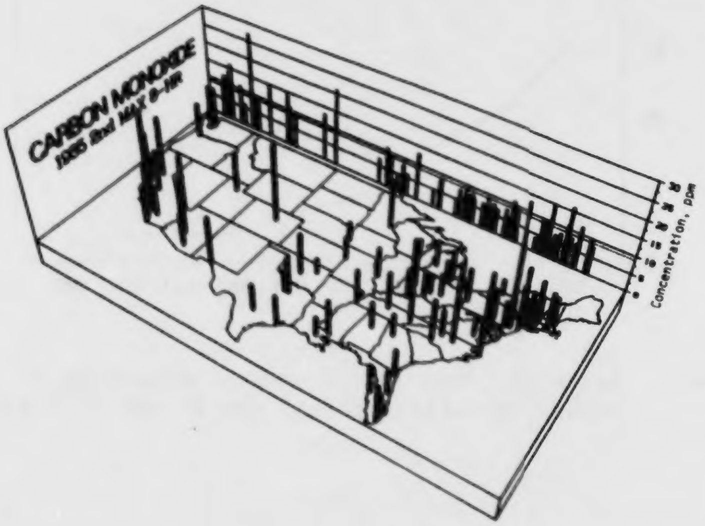
CARBON MONOXIDE
1985 2nd MAX 8-HR
0
5
10
15
20
25
30
Concentration, ppm

Figure 1-14. United States map of the highest second maximum nonoverlapping 8-hour average CO concentration by MSA, 1985.

Nitrogen Dioxide (NO_2) - Annual average NO_2 levels, measured at 108 sites, increased from 1976 to 1979, and decreased through 1985, except for a slight increase in 1984 (Figure 1-15). The 1985 composite NO_2 average, however, is 11 percent lower than the 1976 level indicating a downward trend during the overall period. The trend in the estimated nationwide emissions of nitrogen oxides is similar to the NO_2 air quality trend. Between 1976 and 1985, total nitrogen oxide emissions decreased by 1 percent, and highway vehicle emissions, the source category likely impacting the majority of NO_2 monitoring sites, decreased by 4 percent (Figure 1-16). Between 1984 and 1985, the NO_2 composite average decreased by 2 percent, while the estimated emissions of nitrogen oxides increased by 2 percent. This small year-to-year difference between the ambient levels and the emissions percent change is likely not significant given the relatively low ambient NO_2 levels. The most recent 1985 highest annual arithmetic mean NO_2 concentration is plotted for the 89 largest MSA(s) (Figure 1-17). Los Angeles, California is the only area in the country exceeding the air quality standard of .053 ppm.

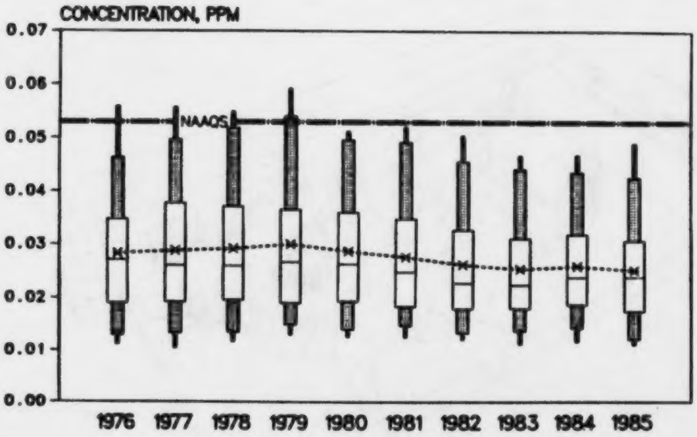

Figure 1-15. National boxplot trend in annual average NO_2 concentrations 1976 - 1985.

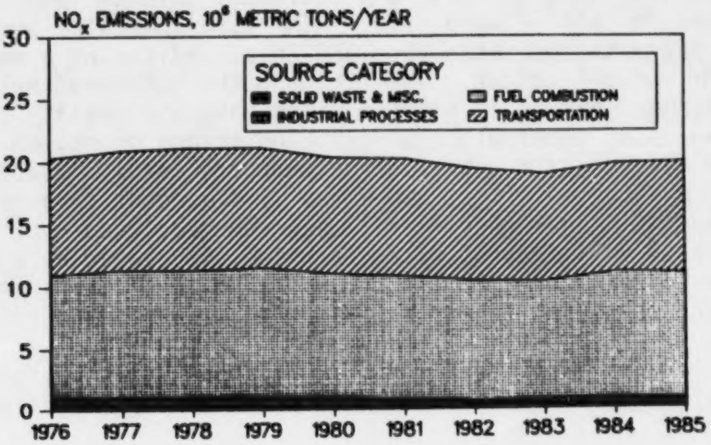

Figure 1-16. National trend in emissions of nitrogen oxides, 1976 - 1985.

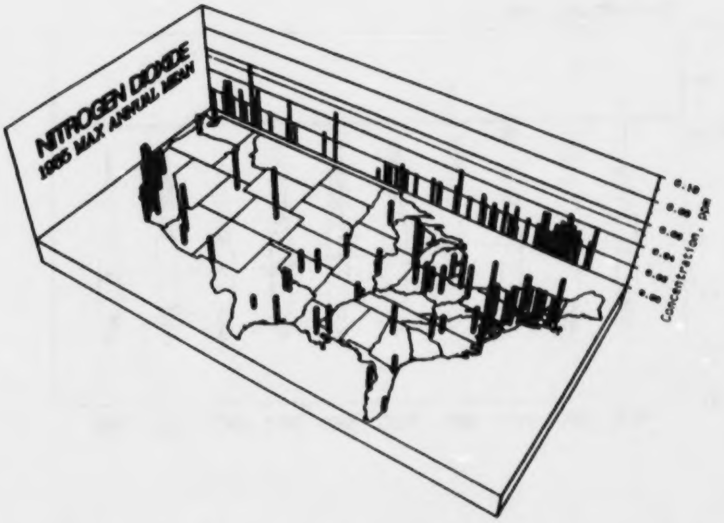
NITROGEN DIOXIDE
1985 MAX ANNUAL MEAN
0.10
0.08
0.06
0.04
0.02
0.00
Concentration, ppm

Figure 1-17. United States map of the highest annual arithmetic mean NO_2 concentration by MSA, 1985.

Ozone (O_3) - Nationally, the composite average of the second highest daily maximum 1-hour O_3 values, recorded at 183 sites, decreased 19 percent between 1976 and 1985 (Figure 1-18). Volatile organic compound (VOC) emissions decreased 11 percent during the same period (Figure 1-19). Although the 1985 composite average for the 163 trend sites is 19 percent lower than the 1976 average, the interpretation of this decrease is complicated by a calibration change for O_3 measurements that occurred in the 1978-79 time period. The stippled portion of Figures 1-18 and 1-20 indicate data affected by measurements taken prior to the calibration change. In the post calibration period (1979 to 1985), O_3 levels decreased 10 percent (Figure 1-18), while VOC emissions decreased 12 percent. The estimated number of exceedances of the O_3 standard decreased 38 percent between 1979 and 1985. (Figure 1-20). The O_3 trends in the 1980's show that the 1980 and 1983 values were higher than those in 1981, 1982, 1984, and 1985. Previous trends reports [11,12] have discussed the likelihood that the higher 1983 levels were influenced by meteorological conditions in that year that were more conducive to ozone formation than conditions in adjacent years. While 1985 levels are similar to 1984 levels, there was a slight improvement of 2 percent in the national composite average between these 2 years. The most recent 1985 highest second daily maximum 1-hour average O_3 concentration is plotted for the 89 largest MSAs (Figure 1-21). Many of these areas did not meet the 0.12 ppm standard in 1985. The highest concentrations are observed in Southern California, but high levels also persist in the Texas Gulf Coast, Northeast corridor, and other heavily populated regions.

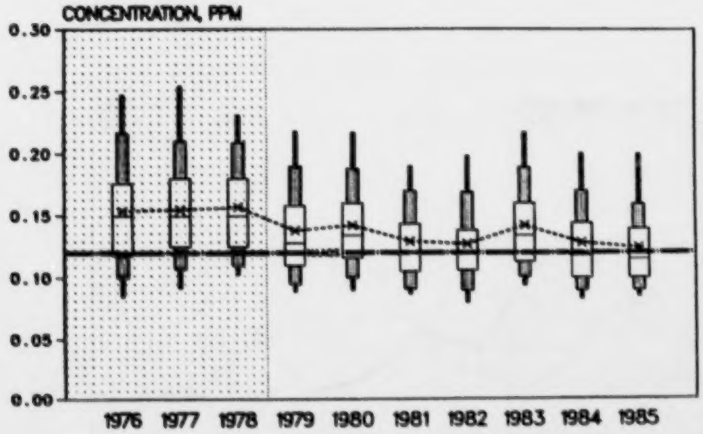

Figure 1-18. National boxplot trend in the second highest daily maximum 1-hour O_3 concentrations, 1976 - 1985.

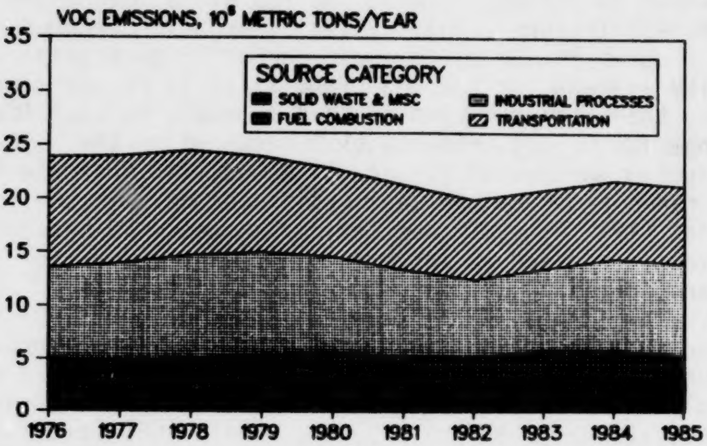

Figure 1-19. National trend in emissions of volatile organic compounds, 1976 - 1985.

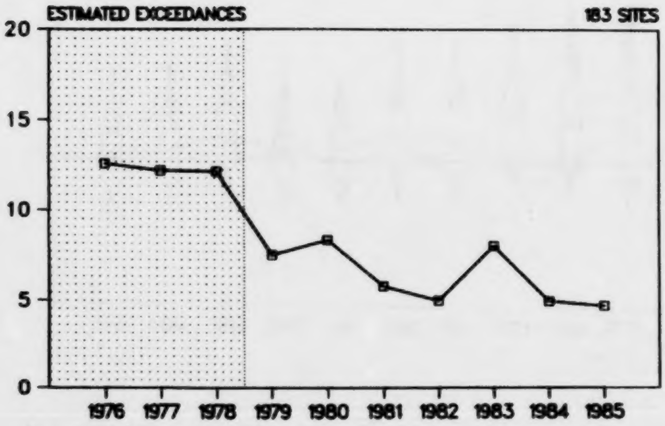

Figure 1-20. National trend in the composite average of the number of daily exceedances of the O_3 NAAQS in the O_3 season, 1976 - 1985.

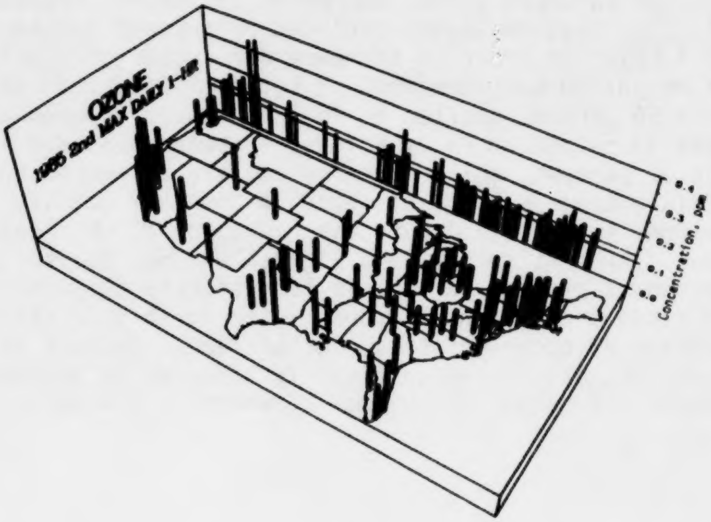
OZONE
1985 2nd MAX DAILY 1-HR
0.4
0.3
0.2
0.1
0.0
Concentration, ppm

Figure 1-21. United States map of the highest second daily maximum 1-hour average O_3 concentration by MSA, 1985.

Lead (Pb) - The composite maximum quarterly average of ambient Pb levels, recorded at 53 urban sites, decreased 79 percent between 1976 and 1985 (Figure 1-22). Lead emissions declined 86 percent during the same period (Figure 1-23). In order to increase the number of trend sites, the 1981 to 1985 time period was examined. A total of 241 trend sites (1981 to 1985) measured a 50 percent decline in Pb levels, corresponding to a 62 percent decrease in estimated Pb emissions. Between 1984 and 1985 ambient Pb levels declined 32 percent, while Pb emissions are estimated to have declined 48 percent. This extremely large decrease in both air quality levels and estimated emissions is largely due to the reduction of the lead content of leaded gasoline. The most recent 1985 highest maximum quarterly average lead concentration is plotted for the 89 largest MSAs (Figure 1-24). The highest concentrations are found throughout the country in cities containing nonferrous smelters or other point sources of lead. Because of the switch to unleaded gasoline, other areas, primarily affected by automotive lead emissions, show levels below the current standard of 1.5 ug/m^3.

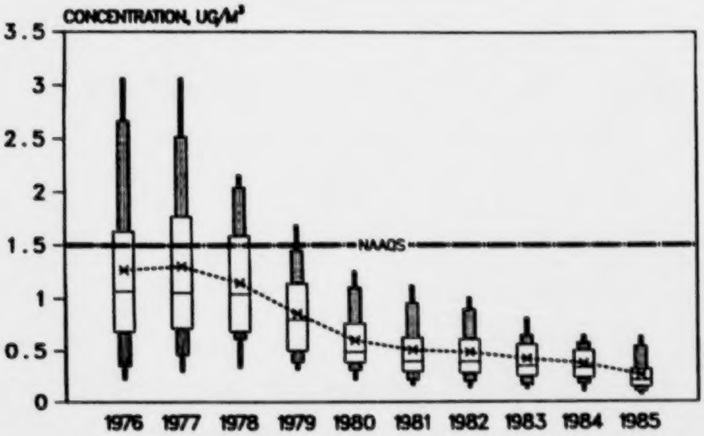

Figure 1-22. National boxplot trend in maximum quarterly average Pb concentrations, 1976 - 1985.

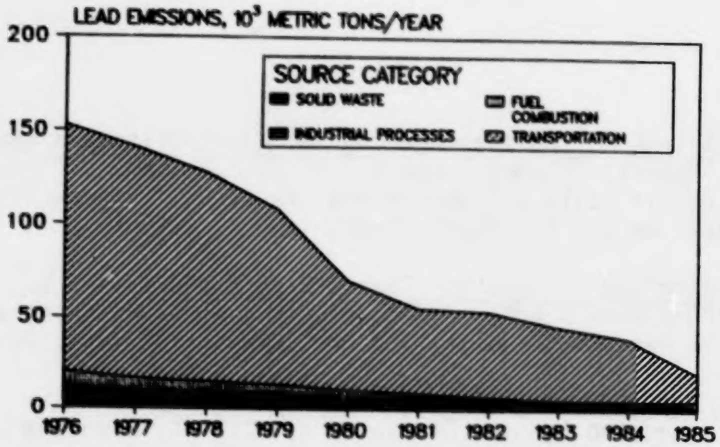

Figure 1-23. National trend in lead emissions, 1976 - 1985.

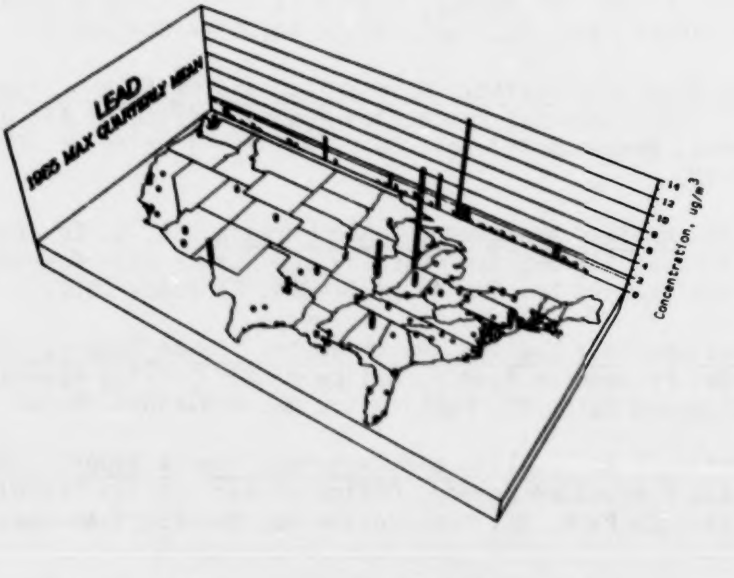
LEAD
1985 MAX QUARTERLY MEAN
0
2
4
6
8
10
12
14
Concentration, ug/m³

Figure 1-24. United States map of the highest maximum quarterly average lead concentration by MSA, 1985.

1.3 REFERENCES

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9. National Air Quality and Emissions Trends Report, 1981. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/4-83-011. April 1983.

10. National Air Quality and Emissions Trends Report, 1982. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/4-84-002. March 1984.

11. National Air Quality and Emissions Trends Report, 1983. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/4-84-029. April 1985.

12. National Air Quality and Emissions Trends Report, 1984. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/4-86-001. April 1986.

13. Federal Register, Vol. 43, June 22, 1978, pp 26971-26975.

14. Hauser, Thomas R., U. S. Environmental Protection Agency, memorandum to Richard G. Rhoads, January 11, 1984.

15. Frank, N. H., "Nationwide Trends in Total Suspended Particulate Matter and Associated Changes in the Measurement Process," Proceedings of the APCA/ASQC Specialty Conference, "Quality Assurance in Air Pollution Measurement," Boulder, CO. October 1984.

2. INTRODUCTION

This report focuses on both 10-year (1976-1985) and 5-year (1981-1985) national air quality trends in each of the major pollutants as well as Regional and, where appropriate, short-term air quality trends. The national analyses are complemented in Section 5 with air quality trends in selected urbanized areas for the period 1981 through 1985. In both the national 5-year trend and the urbanized area trends, the shorter time period was used to expand the number of sites available for trend analysis. The areas that were examined are: Atlanta, GA; Baltimore, MD; Boston, MA; Chicago, IL-Northwestern IN; Denver, CO; Detroit, MI; Houston, TX; Los Angeles-Long Beach, CA; New York, NY-Northeastern NJ; Philadelphia, PA-NJ; Phoenix, AZ; Portland, OR-WA; and St. Louis, MO-IL; Seattle, WA.

The national air quality trends are presented for all sites and the National Air Monitoring Station (NAMS) sites. The NAMS were established through monitoring regulations promulgated in May 1979[1] to provide accurate and timely data to the U. S. Environmental Protection Agency (EPA) from a national air monitoring network. The NAMS are located in areas with high pollutant concentrations and high population exposure. These stations meet uniform criteria for siting, quality assurance, equivalent analytical methodology, sampling intervals, and instrument selection to assure consistent data reporting among the States. Other sites operated by the State and local air pollution control agencies, such as the State and Local Air Monitoring Stations (SLAMS) and Special Purpose Monitors (SPM), in general, also meet the same rigid criteria, except that in addition to being located in the area of highest concentration and high population exposure, they are located in other areas as well. The ambient levels presented are averages of direct measurements.

In addition to ambient air quality, trends are also presented for annual nationwide emissions. These are estimates of the amount and kinds of pollution being emitted by automobiles, factories, and other sources, based upon the best available engineering calculations for a given time period. The emission trends are taken from the EPA publication, National Air Pollutant Emission Estimates, 1940-1985[2] and the reader is referred to this publication for more detailed information. Except for lead emissions which are reported in gigagrams (one thousand metric tons), the emission data are reported as teragrams (one million metric tons) emitted to the atmosphere per year.[2]

Air quality progress is measured by comparing the ambient air pollution levels with the appropriate primary and secondary National

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Ambient Air Quality Standards (NAAQS) for each of the pollutants (Table 2-1). Primary standards protect the public health; secondary standards protect the public welfare as measured by effects of pollution on vegetation, materials, and visibility. The standards are further categorized for long or short term exposure. Long-term standards specify an annual or quarterly mean that may not be exceeded; short-term standards specify upper limit values for 1-, 3-, 8-, or 24-hour averages. With the exception of the pollutant ozone, the short-term standards are not to be exceeded more than once per year. The ozone standard requires that the expected number of days per calendar year with daily maximum hourly concentrations exceeding 0.12 parts per million (ppm) be less than or equal to one.

Section 4 of this report, "Air Quality Levels in Metropolitan Statistical Areas (MSA's);" provides interested members of the air pollution control community, the private sector and the general public with greatly simplified air pollution information. Air quality statistics for the years 1983, 1984 and 1985 are presented for each of the pollutants for all MSA's with populations exceeding 500,000.

2.1 DATA BASE

The ambient air quality data used in this report were obtained from EPA's National Aerometric Data Bank (NADB). Air quality data are submitted to the NADB by both State and local governments, as well as federal agencies. At the present time, there are over 250 million air pollution measurements on the NADB, the vast majority of which represent the more heavily populated urban areas of the Nation.

As in last year's report[3], the size of the available air quality trends data base has been expanded by merging data at sites which have experienced changes in the agency operating the site, the instrument used, or a change in the project code, such as a change from population oriented to special purpose monitoring. A discussion of the impact of the merging of the air quality data is presented in each of the individual pollutant discussions.

In order for a monitoring site to have been included in the national 10-year trend analysis, the site had to contain at least 8 out of the 10 years of data in the period 1976 to 1985. For the national 5-year trend and urban area analyses, the site had to contain 4 out of 5 years of data to be included as a trend site. Each year with data had to satisfy an annual data completeness criterion. To begin with, the air quality data are divided into two major groupings -- 24-hour measurements and continuous 1-hour measurements. The 24-hour measurements are obtained from monitoring instruments that produce one measurement per 24-hour period and are operated on a systematic sampling schedule of once every 6 days or 61 samples per year. Such instruments are used to measure TSP, SO_2, NO_2, and Pb. For these measurement methods, the NADB

TABLE 2-1. National Ambient Air Quality Standards (NAAQS)

POLLUTANT	PRIMARY (HEALTH RELATED)		SECONDARY (WELFARE RELATED)	
	AVERAGING TIME	CONCENTRATION	AVERAGING TIME	CONCENTRATION
TSP	Annual Geometric Mean	75 ug/m^3	Annual Geometric Mean	60 ug/m^3*
	24-hour	260 ug/m^3	24-hour	150 ug/m^3
SO_2	Annual Arithmetic Mean	(0.03 ppm) 80 ug/m^3	3-hour	1300 ug/m^3 (0.50 ppm)
	24-hour	(0.14 ppm) 365 ug/m^3		
CO	8-hour	9 ppm (10 mg/m^3)	No Secondary Standard**	
	1-hour	35 ppm (40 mg/m^3)	No Secondary Standard**	
NO_2	Annual Arithmetic Mean	0.053 ppm (100 ug/m^3)	Same as Primary	
O_3	Maximum Daily 1-hour Average	0.12 ppm (235 ug/m^3)	Same as Primary	
Pb	Maximum Quarterly Average	1.5 ug/m^3	Same as Primary	

*This annual geometric mean is a guide to be used in assessing implementation plans to achieve the 24-hour standard of 150 ug/m^3.

**Because no standards appear to be requisite to protect the public welfare from any known or anticipated adverse effects from ambient CO exposures, EPA rescinded the existing secondary standards.

defines a valid quarter's record as one consisting of at least five sample measurements representively distributed among the months of that quarter. Distributions of measurements that show no samples in 2 months of a quarter or that show no samples in 1 month and only one sample in another month are judged unacceptable for calculating a representative estimate of the mean. A valid annual mean for TSP, SO_2 and NO_2, measured with this type of sampler, requires four valid quarters to satisfy the NADB criteria. For the pollutant lead, the data used has to satisfy the criteria for a valid quarter in at least 3 of the 4 possible quarters in a year for the national trend.

The 1-hour data are obtained from monitoring instruments that operate continuously, producing a measurement every hour for a possible total of 8760 hourly measurements in a year. For continuous hourly data, a valid annual mean for SO_2 and NO_2 requires at least 4380 hourly observations. This same annual data completeness criteria of at least 4380 hourly values was required for the CO standard related statistics - the second maximum nonoverlapping 8-hour average and the estimated number of exceedances of the 8-hour average CO standard.

A slightly different criterion was used for the SO_2 standard related daily statistics - the second daily maximum 24-hour average and the estimated number of daily exceedances of the SO_2 standard. Instead of requiring 4380 or more hourly values, 182 or more daily values were required. A valid day is defined as one consisting of at least 18 hourly observations. This minor modification in the criteria resulted in a 3 percent difference in the total number of SO_2 trend sites for the 10 year trend evaluation of the annual arithmetic mean, 264 sites, as opposed to 257 trend sites for the evaluation of both the second maximium daily average and the estimated number of standard exceedances. There was no difference in the number of SO_2 trend sites for the 5 year trend period. Each statistic - annual arithmetic mean, the second maximum daily average and the estimated number of exceedances - had the same number of trend sites.

Finally, because of the seasonal nature of ozone, both the second daily maximum 1-hour value and the estimated number of exceedances of the O_3 NAAQS were calculated for the ozone season, which varies by State.[4] For example, in California the ozone season is defined as 12 months, January through December, while in New Jersey it is defined as 7 months, April through October. In order for a site to be included it had to have at least 50 percent of the daily data in the ozone season.

For all the pollutants, the site must satisfy the annual completeness criterion, specified above, in at least 8 out of 10 years to be included in the 10-year air quality trends data base and 4 out of 5 years in both the 5-year trend and urbanized area trend data bases. The shorter time period was used in the urbanized area analyses to expand the number of sites available for trend analyses.

In calculating the national and urban area trend analyses, each site was weighted equally. The report examines both 10-year (1976 to 1985) and 5-year (1981 to 1985) trends. The 5-year trend period is introduced to increase the number of trend sites available for analysis (Table 2-2). The trend from 1981 on reflects the period following the promulgation of the monitoring regulations.[1] The regulations required uniform siting of monitors and placed greater emphasis on quality assurance. In general, the data from the post 1981 period should be of the highest quality. As would be expected, there are considerably more trend sites for the 5-year period than the 10-year period - 4003 total trend sites versus 2171 trends sites, respectively (Table 2-2). This 84 percent increase in the number of trends sites for the 5-year period over the 10-year period reflects the greater utilization of the ambient air quality data that is achieved by examining the shorter time period. Trend sites can be found in all EPA Regions (Figure 2-1) for TSP, SO_2, CO, NO_2 and O_3 and lead for the 5-year period.

2.2 TREND STATISTICS

The air quality analyses presented in this report comply with the recommendations of the Intra-Agency Task Force on Air Quality Indicators.[5] This task force was established in January 1980 to recommend standardized air quality indicators and statistical methodologies for presenting air quality status and trends. The Task Force report was published in February 1981. The air quality statistics used in these pollutant-specific trend analyses relate directly to the appropriate NAAQS's. Two types of standard-related statistics are used - peak statistics (the second maximum 24-hour SO_2 average, the second maximum nonoverlapping 8-hour CO average, and the second daily maximum 1-hour O_3 average) and long-term averages (the annual geometric mean for TSP, the annual arithmetic means for SO_2 and NO_2, and the quarterly arithmetic mean for lead). In the case of the peak statistics, the second maximum value is used, because this is the value which traditionally has been used to determine whether or not a site has or has not violated an air quality standard in a particular year, and, therefore, the second maximum value is of significant importance. A composite average of each of these statistics is used, by averaging each statistic over all available trend sites, in the graphical presentations which follow.

In addition to the standard related statistics, other statistics are used, when appropriate, to further clarify observed air quality trends. Particular attention is given to the estimated number of exceedances of the short-term NAAQS's. The estimated number of exceedances is the measured number of exceedances adjusted to account for incomplete sampling.

TABLE 2-2. Comparison of Number of Sites for 10-Year and 5-Year Air Quality Trends

	NUMBER OF SITES		% CHANGE IN THE NUMBER OF TREND SITES
POLLUTANT	1976-85 TREND	1981-85 TREND	1976-85 vs. 1981-85
Total Suspended Particulate (TSP)	1400	2094	+50%
Sulfur Dioxide (SO_2)	264	547	+107%
Carbon Monoxide (CO)	163	355	+118%
Ozone (O_3)	183	523	+186%
Nitrogen Dioxide (NO_2)	108	243	+125%
Lead (Pb)	53	241	+354%
Total	2171	4003	+84%

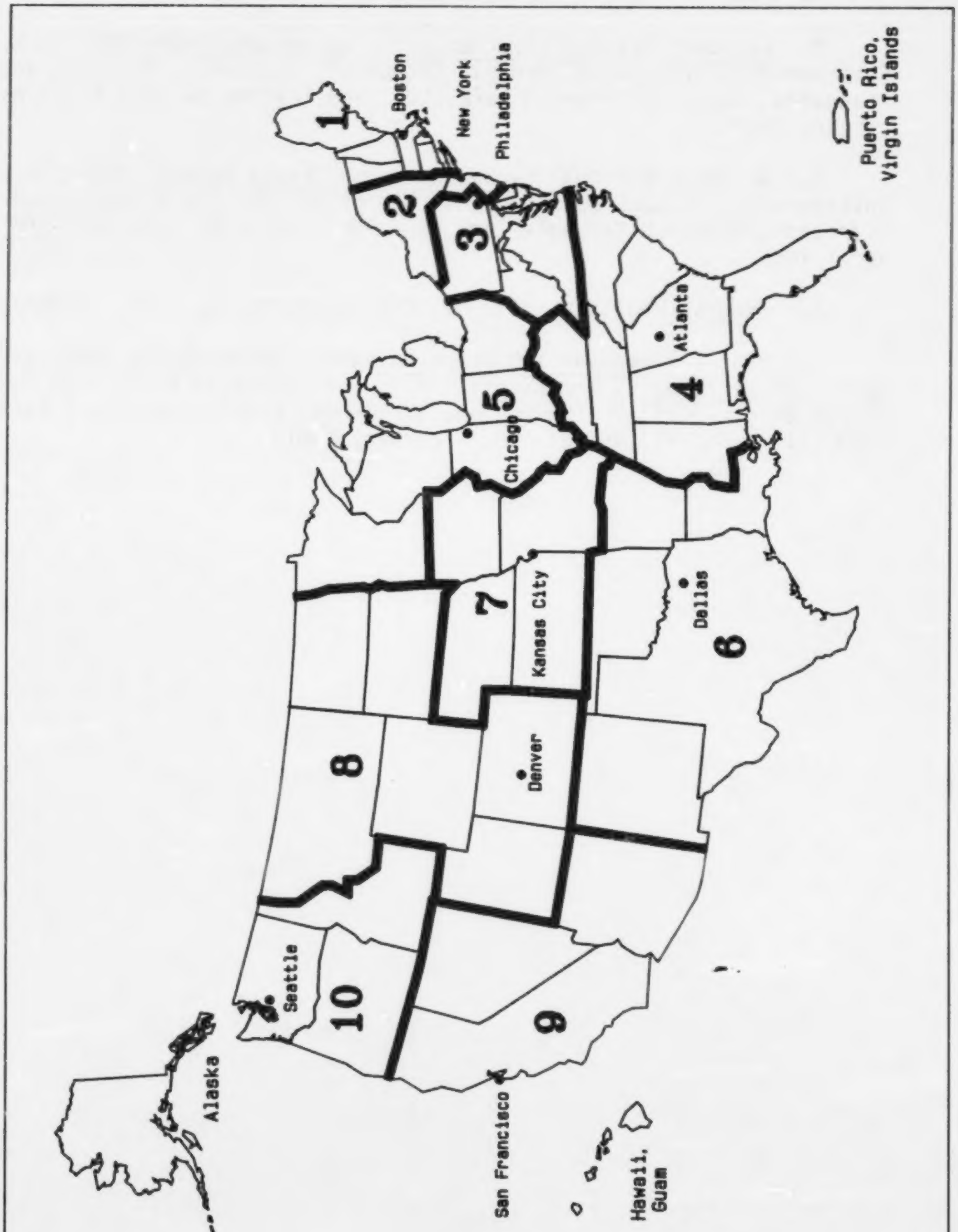
1
Boston
2
New York
3
Philadelphia
4
Atlanta
5
Chicago
6
Dallas
7
Kansas City
8
Denver
9
San Francisco
10
Seattle
Alaska
Hawaii,
Guam
Puerto Rico,
Virgin Islands

Figure 2-1. Ten Regions of the U.S. Environmental Protection Agency.

2.3 REFERENCES

1. Federal Register, Vol. 44, May 10, 1979, pp 27558-27604.

2. National Air Pollutant Emission Estimates, 1940-1985. U.S. Environmental Protection Agency. Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA 450/4-86-018. January 1987.

3. National Air Quality and Emission Trends Report, 1984. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA 450/4-86-001. April 1986.

4. Federal Register, Vol. 51, No. 53, March 19, 1986, pp 9597-9598.

5. U.S. Environmental Protection Agency Intra-Agency Task Force Report on Air Quality Indicators. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA 450/81-015. February 1981.

3. NATIONAL AND REGIONAL TRENDS IN CRITERIA POLLUTANTS

This chapter focuses on both 10-year (1976-1985) and more recent 5-year (1981-1985) trends in each of the six major pollutants, as well as short term air quality trends. Comparisons are made between all the trend sites and the subset of NAMS. Trends are examined for both the Nation and the ten EPA Regions.

The air quality trends data base has been expanded for all pollutants by merging data at sites which have experienced changes in the agency operating the site, the instrument used, or the designation of the project code, such as residential to commercial. The impact of merging the air quality data is discussed in each of the individual pollutant sections.

The air quality trends information is presented using trend lines, confidence intervals, boxplots[1] and bar graphs. This report presents statistical confidence intervals to facilitate a better understanding of measured changes in air quality. Confidence intervals are placed around composite averages, which are based on sites that satisfy annual data completeness requirements. The confidence intervals can be used to make comparisons between years; if the confidence intervals for any 2 years do not overlap, then the composite averages of the 2 years are significantly different (Figure 3-1). Ninety-five percent confidence intervals for composite averages of annual means (arithmetic and geometric) and second maxima were calculated from a two-way analysis of variance followed by an application of the Tukey Studentized Range.[2] The confidence intervals for composite averages of estimated exceedances were calculated by fitting Poisson distributions[3] to the exceedances each year and then applying the Bonferroni multiple comparisons procedure.[4] The utilization of these procedures is explained in publications by Pollack, Hunt and Curran[5] and Pollack and Hunt.[6]

The boxplots have the advantage of displaying, simultaneously, several features of the data. Figure 3-2 illustrates the use of this technique in presenting the 5th, 10th, 25th, 50th (median), 75th, 90th and 95th percentiles of the data, as well as the composite average. The 5th, 10th and 25th percentiles depict the "cleaner" sites. The 75th, 90th and 95th depict the "dirtier" sites, and the median and average describe the "typical" sites. For example, 90 percent of the sites would have concentrations lower than the 90th percentile. Although the average and median both characterize typical behavior, the median has the advantage of not being affected by a few extremely high observations. The use of the boxplots allow us to simultaneously compare trends in the "cleaner", "typical" and "dirtier" sites.

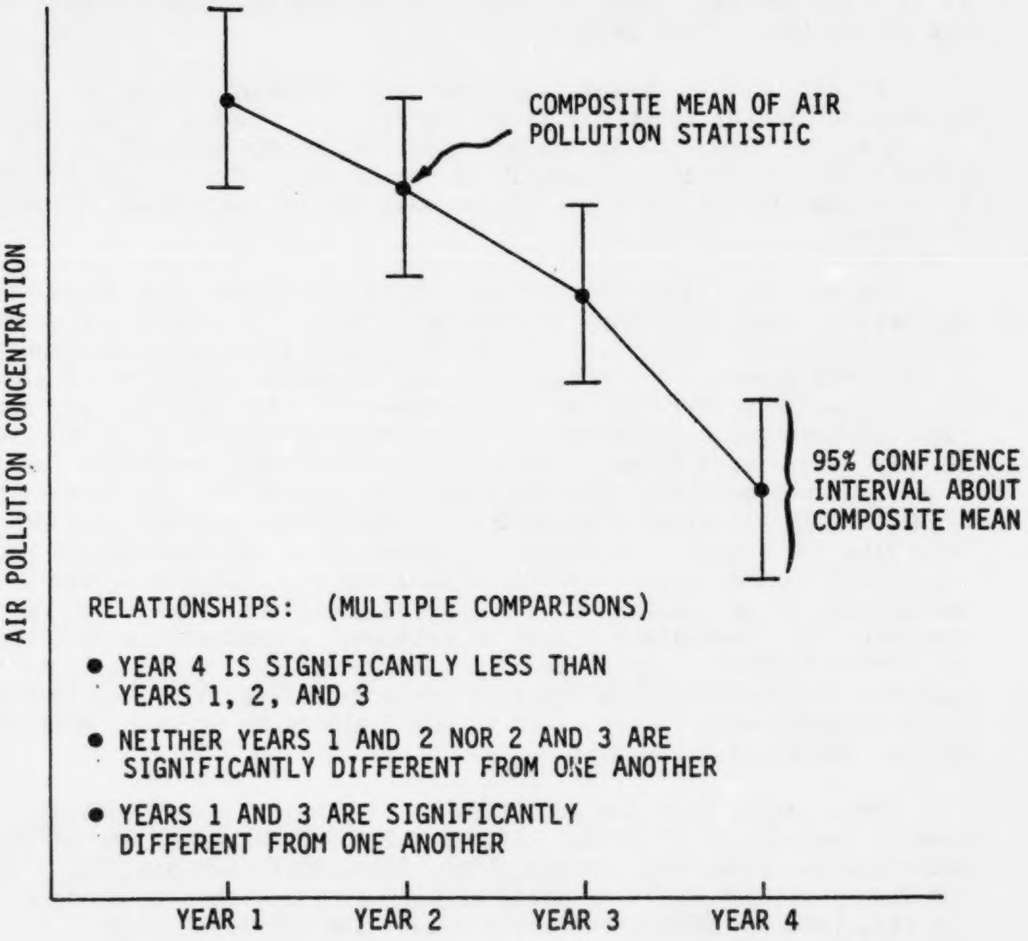

Figure 3-1. Sample illustration of use of confidence intervals to determine statistically significant change.

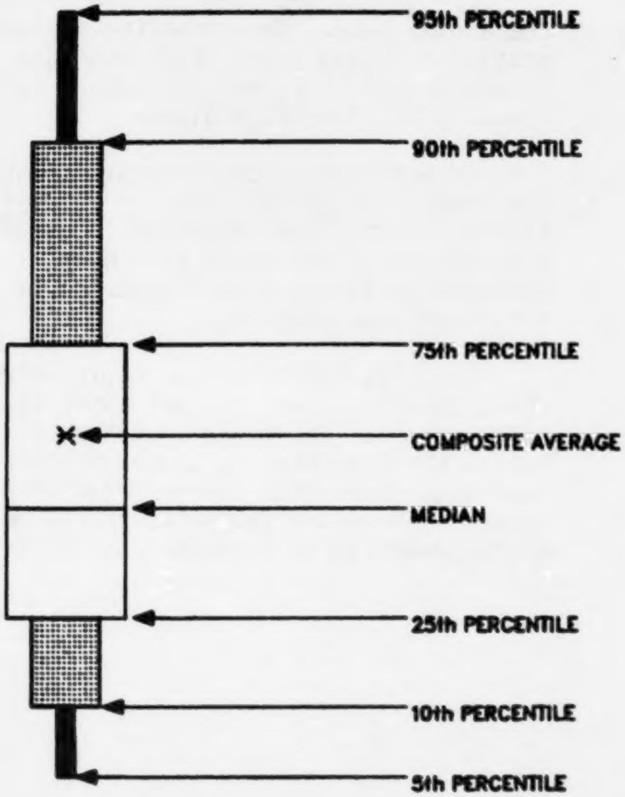
95th PERCENTILE
90th PERCENTILE
75th PERCENTILE
COMPOSITE AVERAGE
MEDIAN
25th PERCENTILE
10th PERCENTILE
5th PERCENTILE

Figure 3-2. Illustration of plotting conventions for box plots.

Boxplots of all trend sites are presented for each year in the 10-year trend. In the recent 5-year trend, the boxplots are presented for the years 1981 through 1985. The recent 5-year trend was introduced in last year's report[7] to increase the number of sites available for analysis. Emphasis is placed on the post-1980 period to take advantage of the larger number of sites and the fact that the data from the post-1980 period should be of the highest quality, with sites meeting uniform siting criteria and high standards of quality assurance.

Bar graphs are used for the Regional comparisons with the 5-year trend data base. The composite average of the appropriate air quality statistic of the years 1983, 1984 and 1985 are presented. The approach is simple and it allows the reader at a glance to compare the short-term trend in all ten EPA Regions.

In addition to the standard related statistics, other statistics are used, when appropriate, to further clarify observed air quality trends. Particular attention is given to the estimated number of exceedances of the short-term NAAQS's. The estimated number of exceedances is the measured number of exceedances adjusted to account for incomplete sampling.

Finally, trends are also presented for annual nationwide emissions. These emissions data are estimated using the best available engineering calculations. The emission data are reported as teragrams (one million metric tons) emitted to the atmosphere per year, with the exception of lead emissions which are reported as gigagrams (one thousand metric tons).[8] These are estimates of the amount and kinds of pollution being generated by automobiles, factories, and other sources.

3.1 TRENDS IN TOTAL SUSPENDED PARTICULATE

Total suspended particulate (TSP) is a measure of suspended particles in the ambient air. These particles originate from a variety of stationary and mobile sources. TSP is measured using a high volume sampler which simply measures the total ambient particle concentration from suspended particles ranging up to approximately 45 microns in diameter. It does not provide additional information regarding particle size. There are both annual geometric mean and 24-hour National Ambient Air Quality Standards for TSP. The annual geometric mean standard is 75 micrograms per cubic meter (ug/m^3) not to be exceeded, while the 24-hour standard is 260 ug/m^3 not to be exceeded more than once per year. Because the annual mean is a more stable estimator of air quality, given the EPA recommended sampling frequency of once every 6 days, only the annual mean is used as a trend statistic.

3.1.1 Long-Term TSP Trends: 1976-85

The 10-year trend in average TSP levels, 1976 to 1985, is shown in Figure 3-3 for 1400 sites geographically distributed throughout the Nation and for the subset of 357 National Air Monitoring Stations (NAMS) which are located in the large urban areas. The TSP levels are expressed in terms of the composite average annual geometric mean.

The curves shown in Figure 3-3 indicate a very slight decrease in composite levels from 1976-1981, followed by a sizeable decrease between 1981 and 1982 and stable levels between 1982 and 1985. The NAMS sites show higher composite levels than the sites for the Nation in general, but appear to show a similar pattern. Both curves display their lowest values in 1985. The composite average of TSP levels measured at 1400 sites, distributed throughout the Nation, decreased 24 percent during the 1976 to 1985 time period and the NAMS decreased 23 percent. From the curves in Figure 3-3, it appears that most of this decrease occurred between the measured levels of 1981 and 1982. EPA has found, however, that the TSP data collected during the years 1979-1981 may be biased high due to the glass fiber filter used during these years, and that most of the large apparent 2-year decrease in pollutant concentrations between 1981 and 1982 can be attributed to a change in these filters.[9,10,11] For this reason, the portion of the Figure 3-3 graph corresponding to 1979-1981 is stippled, indicating the uncertainty associated with these data. Due to the change in TSP filters, the pattern of the yearly change in TSP between 1978 and 1982 is difficult to assess. On the basis of comparable filters used in 1978 and 1985, however, the long-term (8-year) improvement in TSP is estimated to be 25 percent. This is based on 1178 sites which measured TSP in both years.

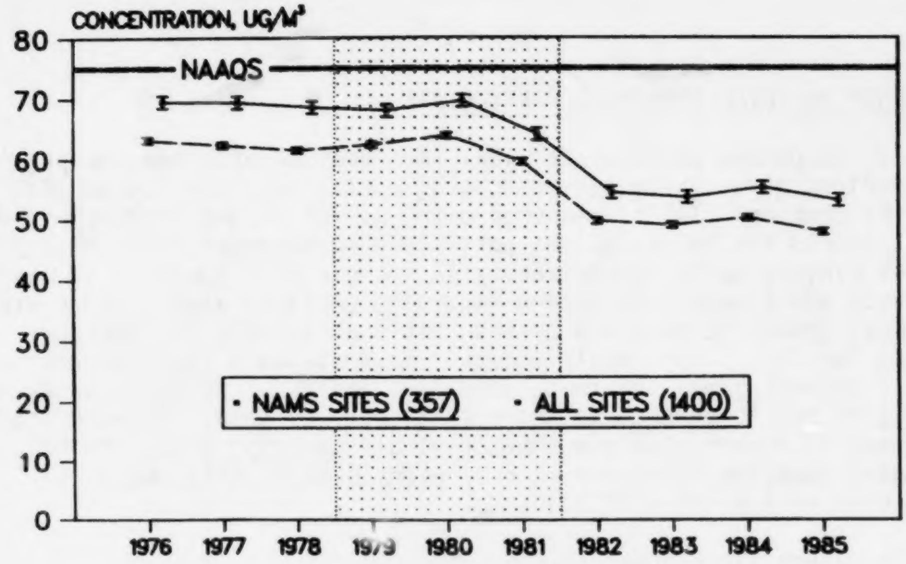

Figure 3-3. National trend in the composite average of the geometric mean total suspended particulate at both NAMS and all sites with 95 percent confidence intervals, 1976-1985.

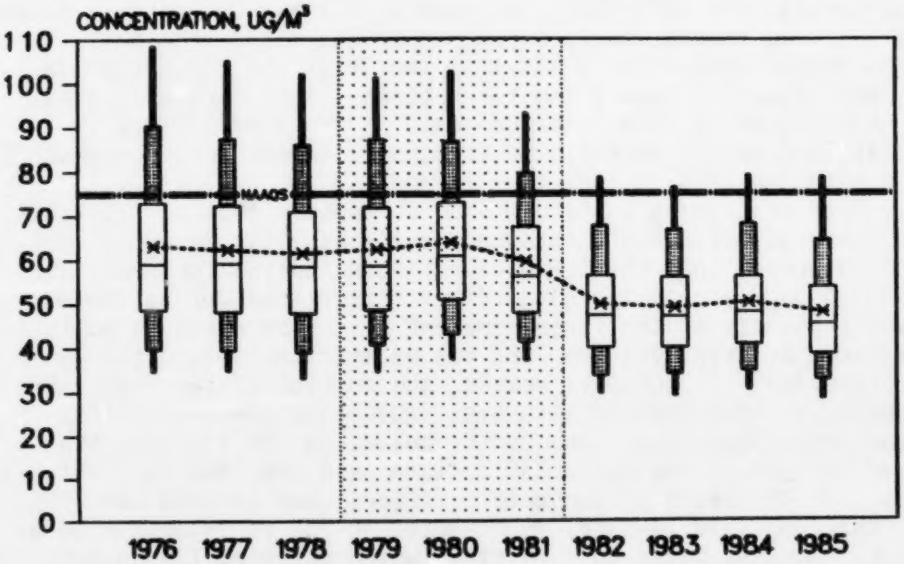

Figure 3-4. Boxplot comparisons of trends in annual geometric mean total suspended particulate concentrations at 1400 sites, 1976-1985.

Figures 3-3 and 3-4 present two different displays of the air quality trend at the 1400 TSP sites, nationally, over the 1976-1985 time period. Both permit evaluation of the 1978 and 1985 TSP levels in the context of the 10 year period, which is used for all pollutants. With 95 percent confidence intervals developed for the composite annual estimates (Figure 3-3), it can be seen that the 1985 as well as the 1982 to 1984 levels are all significantly lower than those of 1978. Moreover 1985 is significantly lower than the 1982 to 1984 period. This difference is discussed in more detail in Section 3.1.2. In Figure 3-4, boxplots present the entire national concentration distribution by year and show that a decrease occurred in every percentile level between 1978 and 1985.

Nationwide TSP emission trends show an overall decrease of 24 percent from 1976 to 1985. (See Table 3-1 and Figure 3-5). The reduction in particulate emissions occurred primarily because of the reductions in industrial processes. This is attributed to a combination of installation of control equipment and reduced industrial activity. Other areas of TSP emission reductions include reduced coal burning by non-utility users and installation of control equipment by electric utilities that burn coal.[8]

3.1.2 Recent TSP Trends: 1981-85

Figure 3-6 presents a boxplot display of the 1981-1985 TSP data base which represents 2094 monitoring sites. The large decrease following 1981 is attributed to the change in monitoring filters discussed in Section 3.1.1. A more practical analysis focuses on the last few years. Figure 3-7 presents a bar chart of regional average TSP. It shows a mixed pattern among the last 3 years, but decreases in TSP were evident in most regions between 1984 and 1985. This supports the decrease seen in national average levels of 4 percent and emission reductions of 3 percent. Only three Regions (I, IX and X) displayed an increase in average TSP. In four of the regions with decreases (III, V, VI and VII), 1985 regional TSP levels were in fact at a 10-year minimum.

Short term variability in air pollution is often due to meteorology. Among all meteorological parameters, precipitation has been shown to have had the greatest influence on particulate air quality. Rainfall has the effect of reducing re-entrainment of particles and washing particles out of the air. An examination of regional precipitation patterns shows that the three regions with 1984-1985 TSP increases were also the only regions which experienced more than a 20 percent decrease in total precipitation, relative to normal.[12] Reduced precipitation probably contributed to air quality degradation in these areas. On the other hand, Regions V and VI were the only regions experiencing increases in precipitation and were among the group showing the largest particulate air quality improvements. Correspondingly, it is likely that some of these regional improvements were due to 1985 being a wetter year.

Table 3-1. National Particulate Emission Estimates, 1976-1985.

(million metric tons/year)

Source Category	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Transportation	1.3	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3
Fuel Combustion	2.5	2.5	2.5	2.4	2.4	2.3	2.2	2.0	2.1	2.1
Industrial Processes	4.4	3.9	3.9	3.8	3.2	3.0	2.5	2.3	2.7	2.7
Solid Waste	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3
Miscellaneous	1.0	0.8	0.8	0.9	1.1	0.9	0.7	1.1	0.9	0.8
Total	9.6	9.0	9.0	8.9	8.4	7.9	7.1	7.0	7.3	7.3

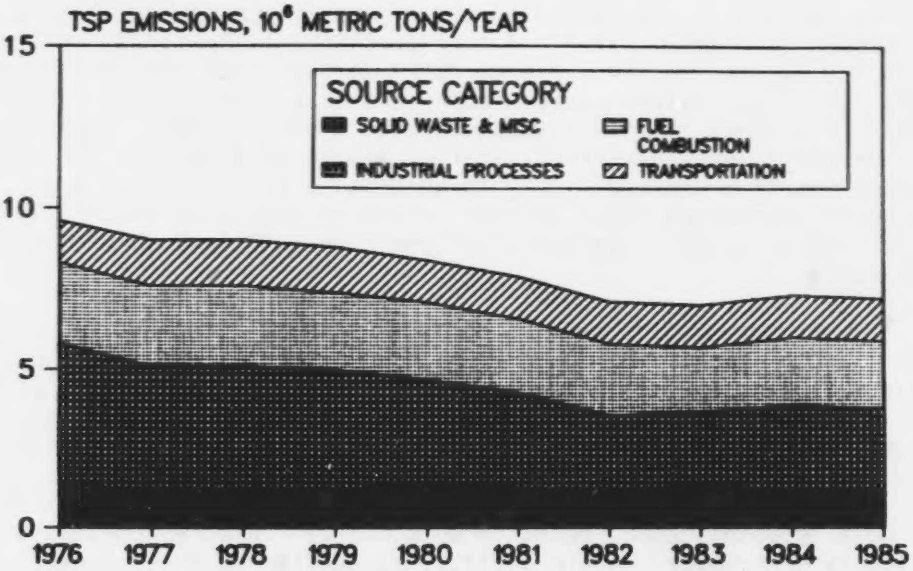

Figure 3-5. National trend in particulate emissions, 1976-1985.

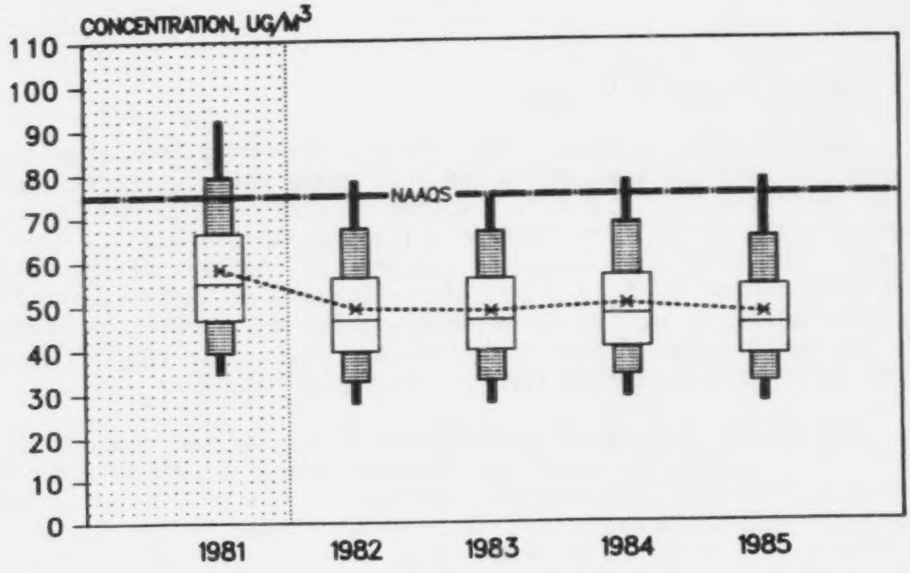

Figure 3-6. Boxplot comparisons of trends in annual mean total suspended particulate concentrations at 2094 sites, 1981-1985.

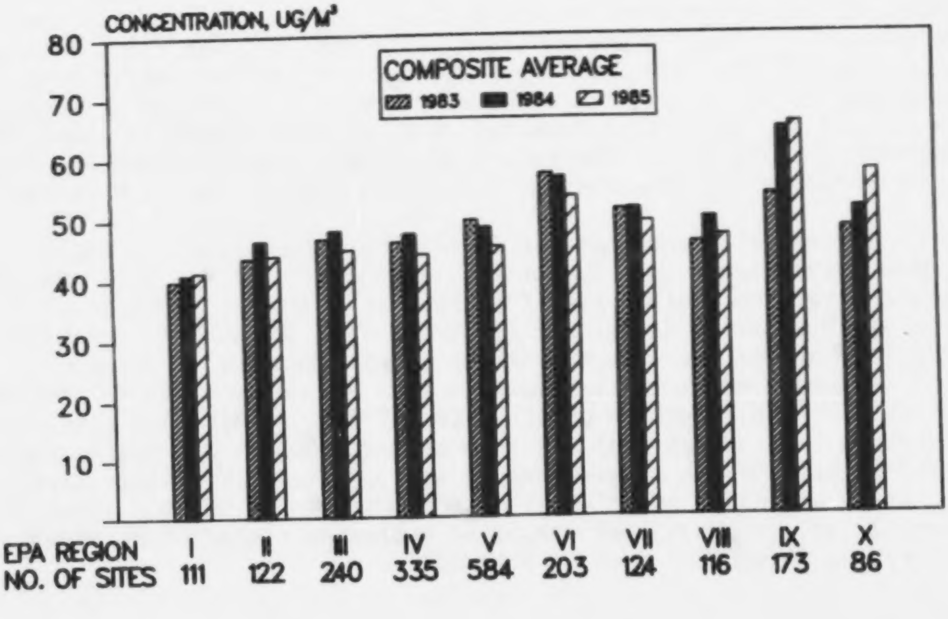

Figure 3-7. Regional comparison of the 1983, 1984, 1985 composite average of the geometric mean total suspended particulate concentration.

3.2 TRENDS IN SULFUR DIOXIDE

Ambient sulfur dioxide (SO_2) results primarily from stationary source coal and oil combustion and from nonferrous smelters. There are three NAAQS for SO_2: an annual arthmetic mean of 0.03 ppm (80 ug/m^3), a 24-hour level of 0.14 ppm (365 ug/m^3) and a 3-hour level of 0.50 ppm (1300 ug/m^3). The first two standards are primary (health-related) standards, while the 3-hour NAAQS is a secondary (welfare-related) standard. The annual standard is not to be exceeded, while the short-term standards are not to be exceeded more than once per year. The trend analyses which follow are presented for the primary standards.

The trends in ambient concentrations are derived from continuous monitoring instruments which can measure as many as 8760 hourly values per year. The SO_2 measurements reported in this section are summarized into a variety of summary statistics which relate to the SO_2 NAAQS. The statistics on which ambient trends will be reported are the annual arithmetic mean concentration, the second highest annual 24-hour average (measured midnight to midnight), and the expected annual number of 24-hour exceedances of the 24-hour standard of 0.14 ppm.

3.2.1 Long-term SO_2 Trends: 1976-85

The long-term trend in ambient SO_2, 1976 to 1985, is graphically presented in Figures 3-8 to 3-10. In each figure, the trend at the NAMS is contrasted with the trend at all sites. For each of the statistics presented, a steady downward trend is evident through 1982, with some leveling off over the last 4 years. Nationally, the annual mean SO_2, examined at 264 sites, decreased at a median rate of approximately 5 percent per year; this resulted in an overall change of about 42 percent (Figure 3-8). The subset of 94 NAMS recorded higher average concentrations but declined at a slightly higher rate of 6 percent per year.

The annual second highest 24-hour values displayed a similar decline between 1976 and 1985. Nationally, among 257 stations with adequate trend data, the median rate of change was 6 percent per year with an overall decline of 44 percent (Figure 3-9). The 89 NAMS exhibited a similar rate of improvement for an overall change of 43 percent. The estimated number of exceedances also showed declines for the NAMS as well as the composite of all sites (Figure 3-10). The vast majority of SO_2 sites, however, do not show any exceedances of the 24-hour NAAQS. Most of the exceedances as well as the bulk of the improvements occurred at source oriented sites including a few smelter sites in particular. The national composite estimated number of exceedances decreased 95 percent from 1976 to 1985.

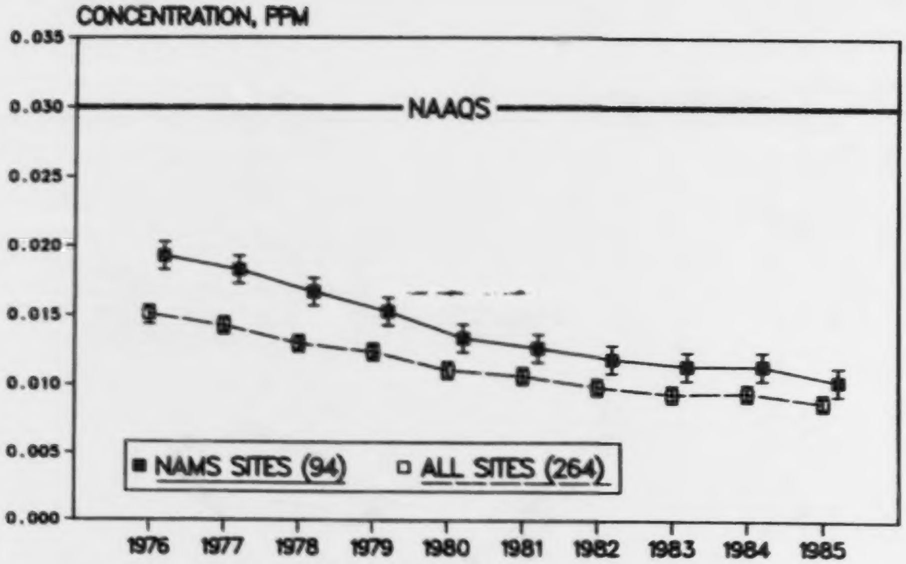

Figure 3-8. National trend in the composite average of the annual average sulfur dioxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1976-1985.

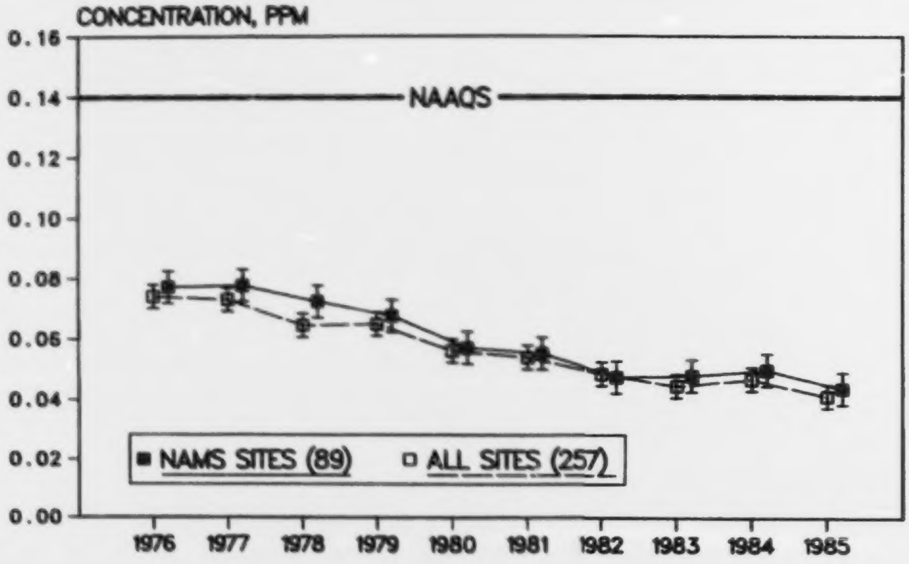

Figure 3-9. National trend in the composite average of the second-highest 24-hour sulfur dioxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1976-1985.

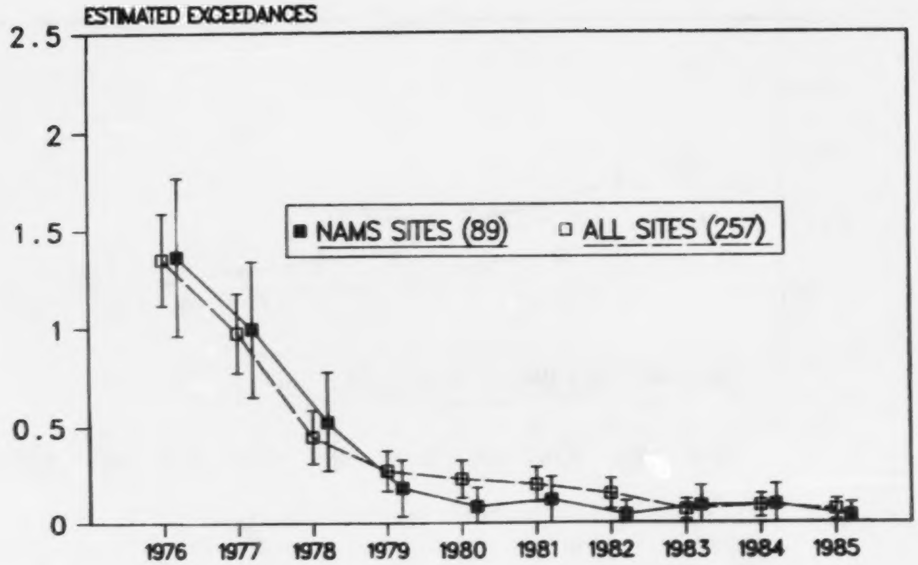

Figure 3-10. National trend in the composite average of the estimated number of exceedances of the 24-hour sulfur dioxide NAAQS at both NAMS and all sites with confidence intervals, 1976-1985.

The statistical significance of these long-term trends is graphically illustrated on Figures 3-8 to 3-10 with the 95 percent confidence intervals included on these figures. For both annual averages and peak 24-hour values, the SO_2 levels in 1985 are the lowest in 10 years but are statistically indistinguishable among the last 4 years. For expected exceedances of the 24-hour standard with its more rapid decline and higher variability, current levels are only statistically different than average exceedances in earlier years (1976-1978).

The inter-site variability for annual mean and annual second highest 24-hour SO_2 concentrations is graphically displayed in Figures 3-11 and 3-12. These figures show that higher concentrations decreased more rapidly and the concentration range among sites has also diminished from the 1970's to the 1980's.

Nationally, sulfur oxide emissions decreased 21 percent from 1976 to 1985 (Figure 3-13 and Table 3-2), reflecting the installation of flue gas desulfurization controls at coal-fired electric generating stations and a reduction in the average sulfur content of fuels consumed. Emissions from other stationary source fuel combustion sectors also declined, mainly due to decreased combustion of coal by these consumers. Sulfur oxide emissions from industrial processes are also significant. Emissions from industrial processes have declined, primarily as the result of controls implemented to reduce emissions from nonferrous smelters and sulfuric acid manufacturing plants.[8]

The disparity between the 42 percent decrease in SO_2 air quality and the 21 percent decrease in SO_2 emissions can be attributed to several factors. SO_2 monitors are mostly urban population-oriented and as such do not monitor many of the major emitters which tend to be located in more rural areas. Among the 264 trend sites used in the analysis of average SO_2 levels, two-thirds are categorized as population-oriented. The remaining sites include those monitors in the vicinity of large power plants, nonferrous smelters and other industrial sources such as paper mills and steel producing facilities.

The residential and commercial areas, where most monitors are located, have shown sulfur oxide emission decreases comparable to SO_2 air quality improvement. These decreases in sulfur oxide emissions are due to a combination of energy conservation measures and the use of cleaner fuels in the residential and commercial areas.[8] Comparable SO_2 trends have also been demonstrated for monitors located in the vicinity of nonferrous smelters which produce some of the highest SO_2 concentrations observed nationally.[7] Smelter sources represent a majority of SO_2 emissions in the intermountain region of the western U.S.

Although one-third of the trend sites are categorized as source-oriented, the majority of SO_2 emissions are dominated by large point sources. Two-thirds of all national SO_2 emissions are generated by electric utilities (94 percent of which come from coal fired power plants). The majority of these emissions, however, are produced by a small number

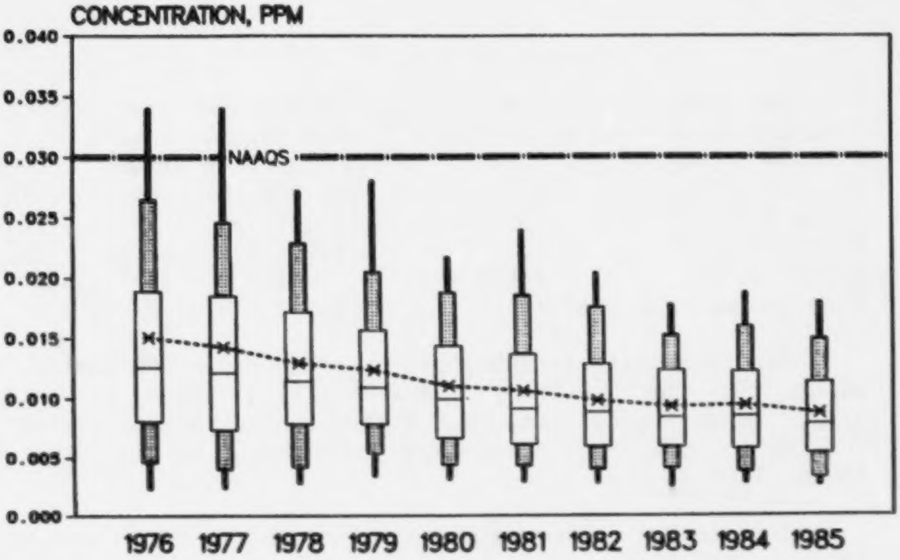

Figure 3-11. Boxplot comparisons of trends in annual mean sulfur dioxide concentrations at 264 sites, 1976-1985.

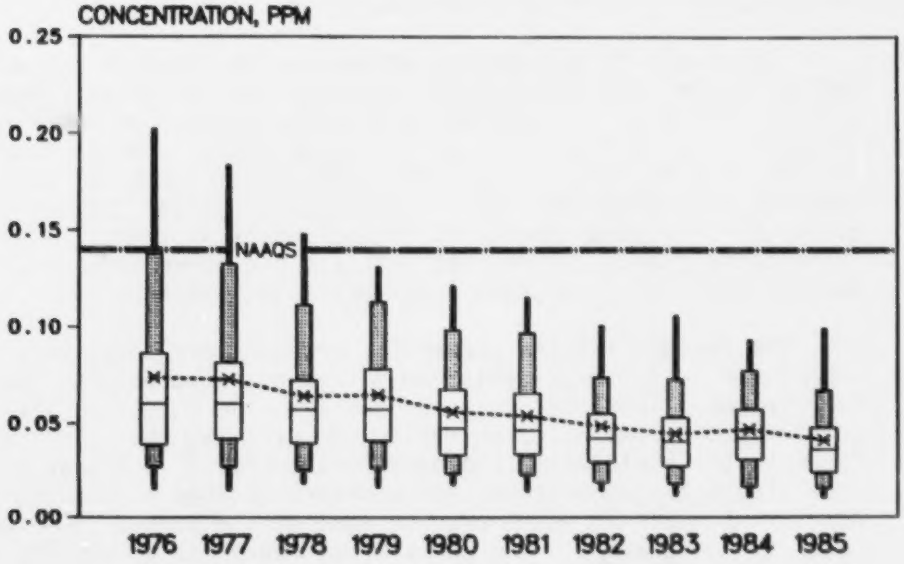

Figure 3-12. Boxplot comparisons of trends in second highest 24-hour average sulfur dioxide concentrations at 257 sites, 1976-1985.

Table 3-2. National Sulfur Oxide Emission Estimates, 1976-1985.

(million metric tons/year)

Source Category	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Transportation	0.7	0.8	0.8	0.9	0.9	0.9	0.8	0.8	0.8	0.8
Fuel Combustion	20.9	21.1	19.5	19.5	18.7	17.8	17.3	16.7	17.4	17.0
Industrial Processes	4.6	4.4	4.1	4.1	3.5	3.7	3.1	3.1	3.1	2.9
Solid Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	26.2	26.3	24.4	24.5	23.2	22.4	21.3	20.5	21.3	20.7

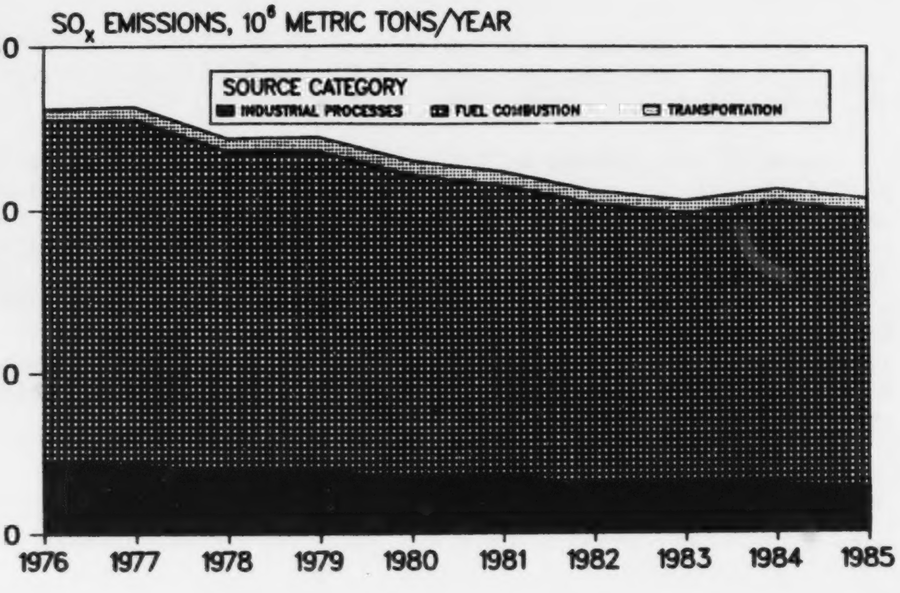

Figure 3-13. National trend in sulfur oxide emissions, 1976-1985.

of facilities. Fifty-three individual plants in 14 states account for one-half of all power plant emissions.[13] In addition, the 200 highest SO_2 emitters account for more than 85 percent of all SO_2 power plant emissions.[13,14] These 200 plants account for 57 percent of all SO_2 emissions, nationally.

Another factor which may account for differences in SO_2 emissions and ambient air quality is stack height. The height at which SO_2 is released into the atmosphere has been increasing at industrial sources and power plants.[15,16] This can permit ground level concentrations to decrease at a faster rate than emissions. Under these circumstances, concentrations can, in fact, decrease even if emissions increase.

3.2.2. Recent SO_2 Trends: 1981-85

Figure 3-14 presents short-term SO_2 trends for annual mean concentrations. The boxplot display for the 1981-1985 data, based on 547 sites, indicate a similar decrease over the same 5-year period included in the long-term trends, but with lower average concentrations. This is attributed to inclusion of new SO_2 monitoring sites in areas with medium to low concentration levels. The 5-year trend shown in Figure 3-14 shows a continued decline in SO_2 concentrations. Air quality levels decreased 5 percent, corresponding to a 3 percent decrease in emissions.

Regional changes in composite average SO_2 concentrations for the last 3 years, 1983-1985 are shown in Figure 3-15. Most regions decreased slightly between 1984 and 1985.

Some of the regions with the lowest average SO_2 also contain some of the highest SO_2 concentrations recorded nationally. This phenomenon which is due to SO_2 in the vicinity of nonferrous smelters, is evident in Figure 3-16 which shows the 1985 intra-regional concentration distributions. Region IX, for example, displays a low overall average concentration as mentioned previously, but also has the highest peak concentration levels in the Nation because of the Arizona smelters. Similarly, large intra-regional variability in SO_2 concentrations is seen in Regions VI,VIII and X because of monitors located in the vicinity of smelters.

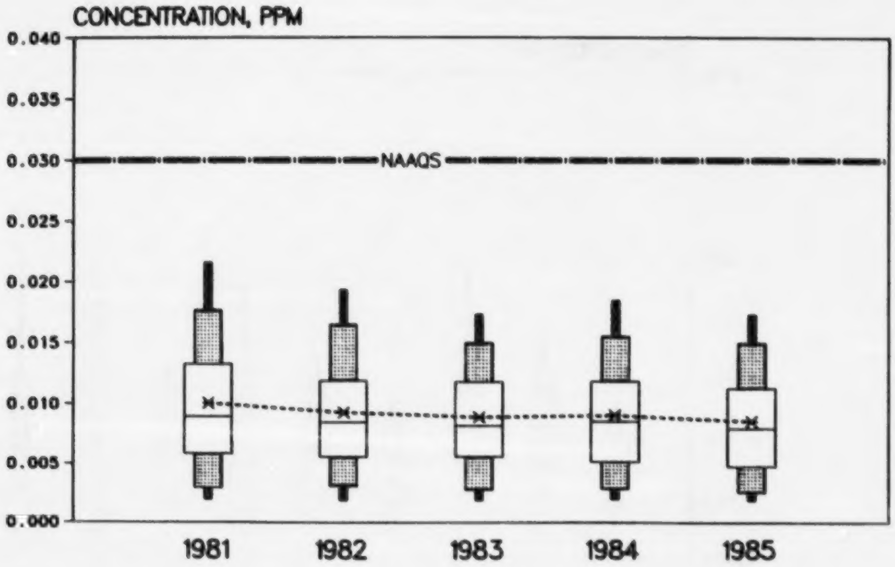

Figure 3-14. Boxplot comparisons of trends in annual mean sulfur dioxide concentrations at 547 sites, 1981-1985.

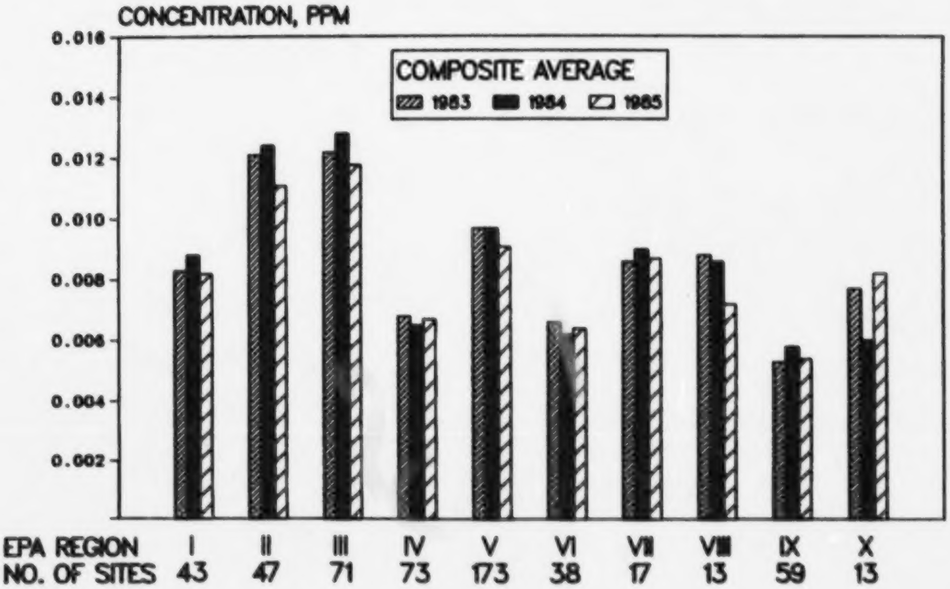

Figure 3-15. Regional comparison of the 1983, 1984, 1985 composite average of the annual average sulfur dioxide concentration.

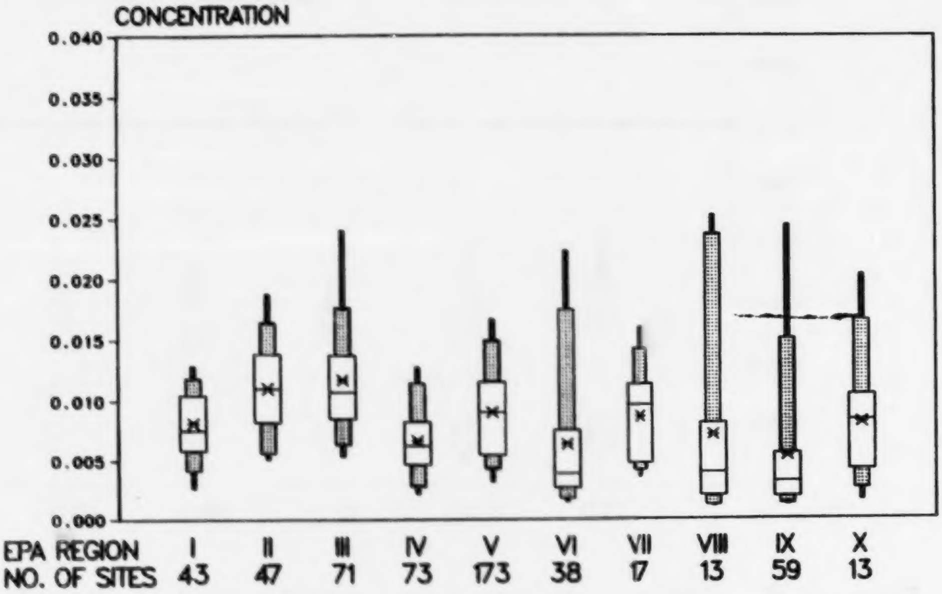

Figure 3-16. Regional boxplot comparisons of the annual average sulfur dioxide concentrations in 1985.

3.3 TRENDS IN CARBON MONOXIDE

Carbon monoxide (CO) is a colorless, odorless, and poisonous gas produced by incomplete burning of carbon in fuels. Transportation sources account for over two-thirds of the nationwide CO emissions with the largest contribution due to highway motor vehicles. The NAAQS for ambient CO specifies upper limits that are not to be exceeded more than once per year for two different averaging times: a 1-hour level of 35 ppm and an 8-hour level of 9 ppm. This analysis concentrates on the 8-hour average results because the 8-hour standard is generally the more restrictive limit.

Trends sites were selected using the procedures presented in Section 2.1. This resulted in a data base of 163 sites for the 1976-85 10-year time period and a data base of 355 sites for the 1981-85 5-year time period. There were 45 NAMS sites included in the 10-year data base and 102 NAMS sites in the 5-year data base. This approximate two-fold increase in the number of trend sites available for the more recent time period is consistent with the improvement in size and stability of current ambient CO monitoring programs.

3.3.1 Ten Year CO Trends: 1976-85

Figure 3-17 presents the national 1976-85 composite average trend for the second highest non-overlapping 8-hour CO value for the 163 long-term trend sites and the subset of 45 NAMS sites. During this 10-year period, the national composite average decreased by 36 percent with a 33 percent decrease for the NAMS subset. The median rate of improvement has been about 5 percent per year but the 1984-85 decrease was twice as large, about 10 percent. The confidence intervals in Figure 3-17 emphasize this overall improvement in CO levels with the concentrations in more recent years being significantly less than those in the earlier years. Eighty-six percent of these trend sites showed long-term improvement in the 1976-85 time period. The same trend is presented in Figure 3-18 but the boxplot provides more information on the distribution of ambient CO levels from year to year at the 163 long-term trend sites. Although certain percentiles show year to year fluctuations, the general long-term improvement is clear.

The 10-year trend in the composite average of the estimated number of exceedances of the 8-hour CO NAAQS is shown in Figure 3-19. This exceedance rate was adjusted to account for incomplete sampling. The trend in exceedances shows long-term improvement but the rates are much more pronounced than those for the second maximums. The composite average for estimated exceedances improved 92 percent between 1976 and 1985 for the 163 long-term trend sites while the subset of 45 NAMS had a similar decrease of 89 percent. These percentage improvements for exceedances are typically much larger than those found for peak concentrations, such as the annual second maximum. The percentage change for the second maximums are more likely to reflect the percentage change in emission levels.

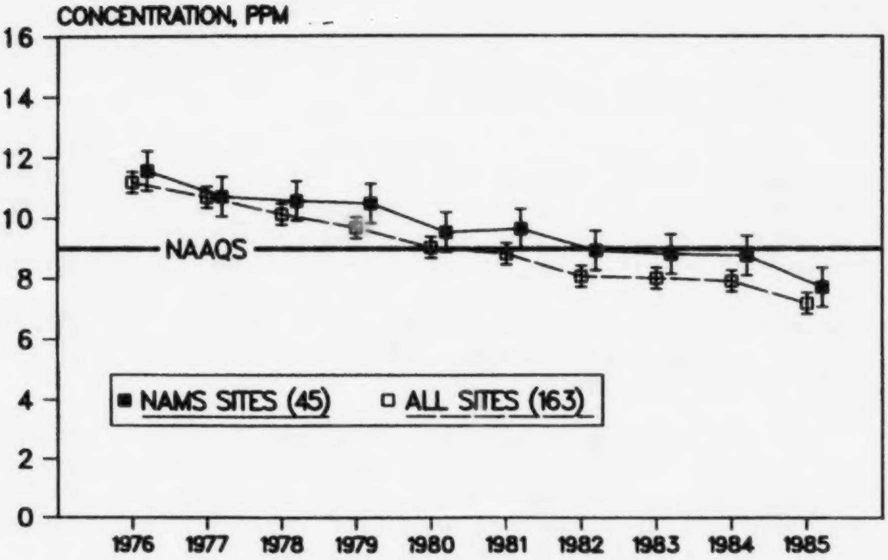

Figure 3-17. National trend in the composite average of the second highest nonoverlapping 8-hour average carbon monoxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1976-1985.

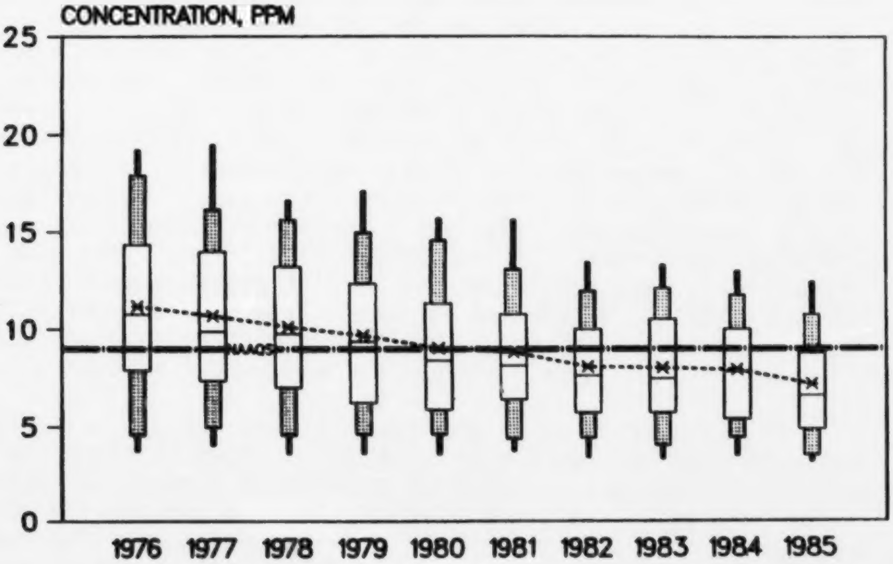

Figure 3-18. Boxplot comparisons of trends in second highest nonoverlapping 8-hour average carbon monoxide concentrations at 163 sites, 1976-1985.

National carbon monoxide emission estimates for 1976 through 1985 are presented in Table 3-3 and depicted graphically in Figure 3-20.[8] These estimates show a 21 percent decrease between 1976 and 1985. Emissions from transportation sources, which accounted for about 70 percent of the total CO emissions in 1975, are estimated to have decreased by 26 percent during this 10-year period. These reductions in CO emissions occurred even though vehicle miles of travel are estimated to have increased by 26 percent between 1976 and 1985. This indicates that the Federal Motor Vehicle Control Program (FMVCP) has been effective on the national scale with controls more than offsetting the growth during this period. The difficulty with comparing these air quality and emission changes is that the emission changes reflect national totals while the ambient CO monitors are frequently located to identify potential problems. Therefore, the mix of vehicles and the change in vehicle miles of travel in the area around a typical CO monitoring site may differ from the national averages.

3.3.2 Five-Year CO Trends: 1981-85

This section examines ambient CO trends for the 5-year time period 1981-85. As discussed in section 2.1, this allows the use of a larger data base, 355 sites versus 163, because the historical data completeness criterion is restricted to the 1981-85 time period so that newer monitoring sites can qualify for inclusion. Figure 3-21 displays the 5-year ambient CO trend in terms of the second highest non-overlapping 8-hour averages. The composite average showed 17 percent improvement between 1981 and 1985 and the boxplot presentation indicates that this type of improvement was seen generally across all levels. Thirty-two percent of these sites had second high values above the level of the 8-hour CO standard in 1981 compared to 18 percent in 1985. The 1984-85 improvement is also clear with a 10 percent decrease in the national composite between these 2 years. At over one-half of these sites, the 1985 value was the lowest for the past 5 years while only 14 percent had their high in 1985.

As shown in Table 3-3, total CO emissions are estimated to have decreased 8 percent between 1981 and 1985. The transportation category, and the subset of highway vehicles, also decreased by 8 percent. Between 1984 and 1985, total CO emissions decreased by 3 percent with transportation sources decreasing by 2 percent. This suggests that the 10 percent improvement in CO air quality between 1984 and 1985 may be influenced in part by other factors such as meteorological conditions or localized control measures. The 1986 data should provide additional information on the strength of this improvement.

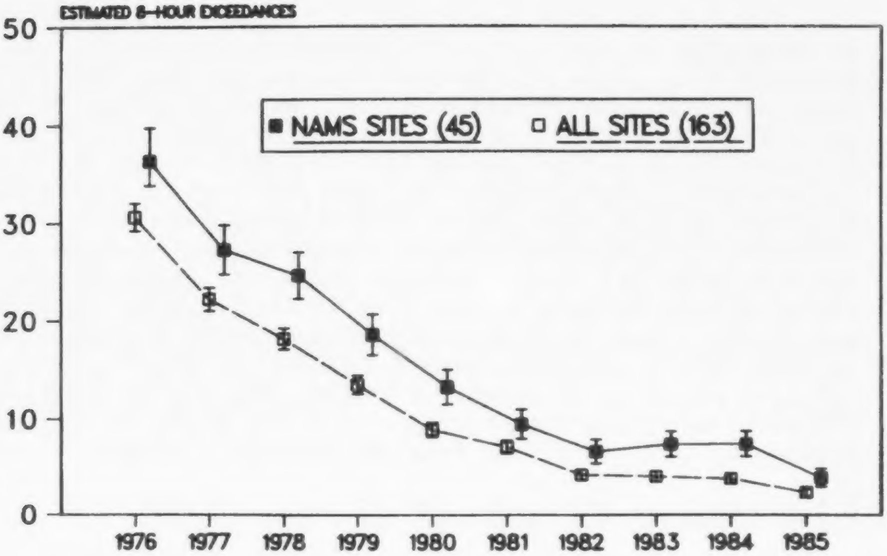

Figure 3-19. National trend in the composite average of the estimated number of exceedances of the 8-hour carbon monoxide NAAQS, at both NAMS and all sites with 95 percent confidence intervals, 1976-1985.

Table 3-3. National Carbon Monoxide Emission Estimates, 1976-1985.

(million metric tons/year)

Source Category	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Transportation	64.1	61.0	60.3	55.9	52.6	51.6	48.1	48.3	48.4	47.5
Fuel Combustion	4.7	5.1	5.8	6.6	7.3	7.5	8.0	7.9	8.1	8.1
Industrial Processes	7.1	7.3	7.1	7.1	6.3	5.9	4.4	4.4	4.8	4.6
Solid Waste	2.7	2.6	2.5	2.3	2.2	2.1	2.0	1.9	1.9	2.0
Miscellaneous	7.1	5.8	5.7	6.5	7.6	6.4	4.9	7.7	6.3	5.3
Total	85.8	81.8	81.4	78.3	76.0	73.4	67.4	70.3	69.6	67.5

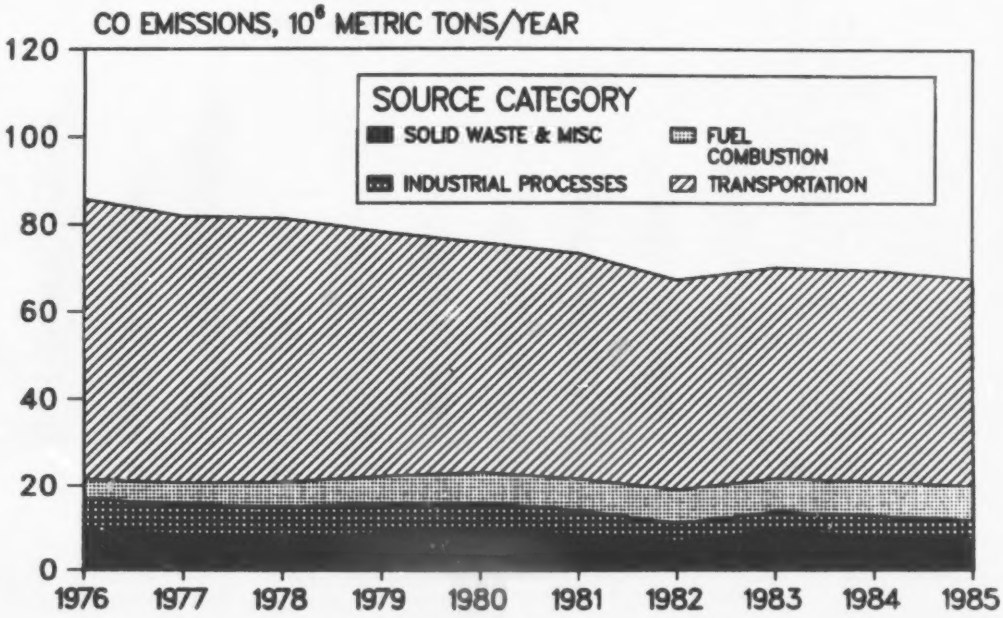

Figure 3-20. National trend in emissions of carbon monoxide, 1976-1985.

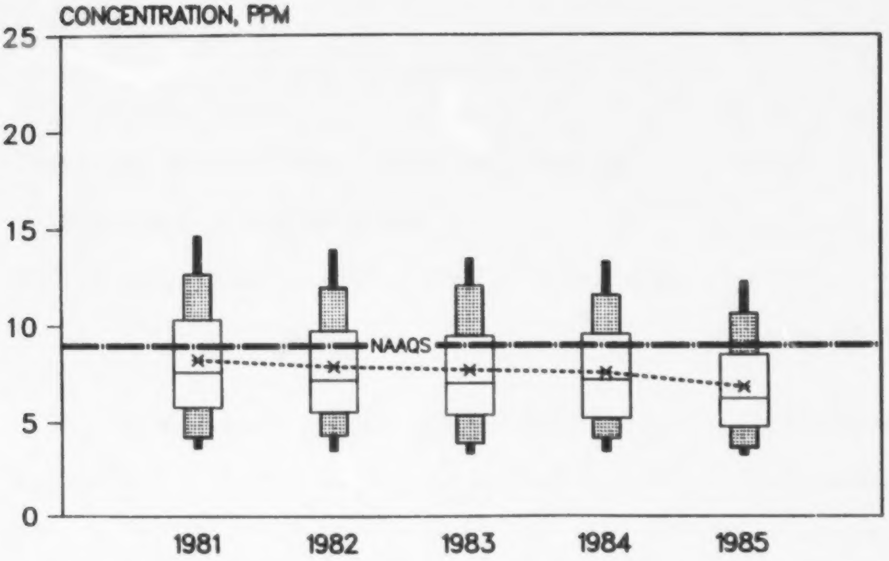

Figure 3-21. Boxplot comparisons of trends in second highest nonoverlapping 8-hour average carbon monoxide concentrations at 355 sites, 1981-1985.

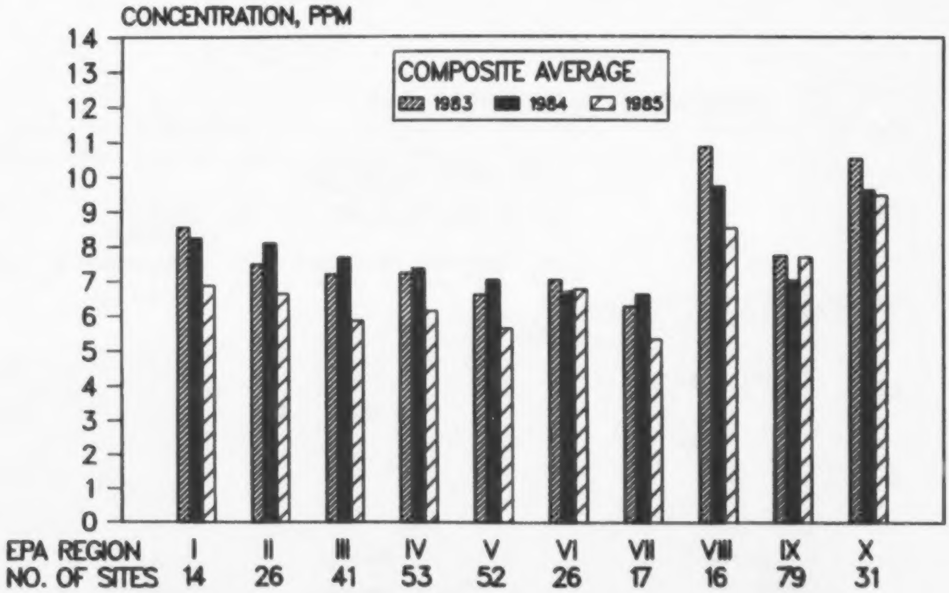

Figure 3-22. Regional comparison of the 1983, 1984, 1985 composite average of the second highest nonoverlapping 8-hour average carbon monoxide concentration.

Composite regional averages for 1983-85 are presented in Figure 3-22 for the second highest non-overlapping 8-hour averages. The improvement between 1984 and 1985 was widespread with only the southwest and far-west departing from this pattern. These regional graphs are primarily intended to depict relative change during this time period rather than typical levels in each region. The mix of monitoring sites may vary from one area to another with one set of sites dominated by center-city monitors in large urban areas while another set of sites may represent a more diversified mix. Therefore, this graph is not intended to be indicative of regional differences in absolute concentration levels.

3.4 TRENDS IN NITROGEN DIOXIDE

Nitrogen dioxide (NO_2), a yellowish, brown gas, is present in urban atmospheres through emissions from two major sources; transportation and stationary fuel combustion. The major mechanism for the formation of NO_2 in the atmosphere is the oxidation of the primary air pollutant, nitric oxide. NO_2 is measured using either a continuous monitoring instrument, which can collect as many as 8760 hourly values a year, or a 24-hour bubbler, which collects one measurement per 24-hour period. Both monitors are used to compare annual average concentrations with the NO_2 standard of 0.053 parts per million.

In order to expand the size of the available trends data base, data were merged at sites which experienced changes in the agency operating the site, the instrument used, or the designation of the project code, such as population oriented or duplicate sampling. The merging was accomplished by treating the bubbler and continuous hourly data separately. For example, if a monitor at a given site was changed from a 24-hour bubbler to a continuous hourly monitor, the data would not be merged. If, however, a monitor at a given site changed from one type of continuous instrument to another type of continuous instrument, the data would be merged.

The trends site selection process, described in Section 2.1, yielded 108 sites for the 1976-85 ten-year period and 243 sites for the 1981-85 5-year data base. Eleven of the long-term trend sites are NAMS while 46 NAMS are included in the 1981-85 data base. The size of the long-term data base has been decreasing each successive year as low concentration sites are discontinued or as NO_2 bubblers are replaced with continuous instruments. In this latter case, data from these two different methods are not merged. Only 33 of the 108 long-term trend sites are NO_2 bubblers.

3.4.1 Ten-year NO_2 Trends: 1976-85

The composite average long-term trend for the nitrogen dioxide mean concentration at the 108 trend sites, and the 11 NAMS sites, is shown in Figure 3-23. Nationally, at all sites, annual average NO_2 levels increased from 1976 to 1979, decreased through 1985, except for a slight increase in 1984. The 1985 composite average NO_2 level is 11 percent lower than the 1976 level, indicating a downward trend during this period. Of the 108 trends sites, only 11 are designated as NAMS. This is to be expected because NO_2 does not present a significant air quality problem in most areas at this time. Also, NAMS for NO_2 are only located in urban areas with populations of 1,000,000 or greater. The composite averages of the NAMS, which are located in eight large metropolitan areas, are higher than those of all sites. Comparing 1985 data to the 1976 levels shows an 11 percent decrease in the composite average for all trends sites and a 14 percent decrease for the NAMS. The discrepancy between the all sites and NAMS year to year changes may be attributed to both the small number of NAMS meeting the 10-year trends completeness criteria and the generally low levels of recorded NO_2 annual mean concentrations, with respect to the level of the NO_2 NAAQS.

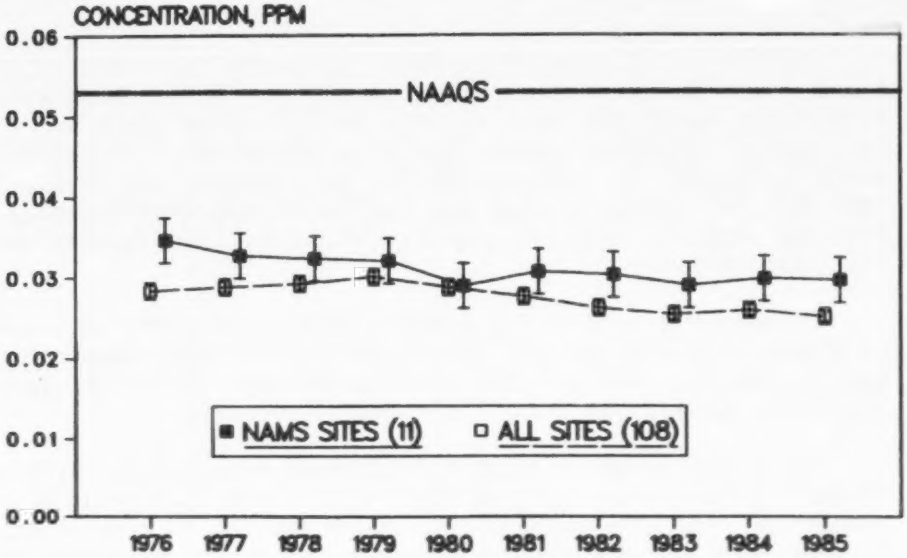

Figure 3-23. National trend in the composite average of nitrogen dioxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1976-1985.

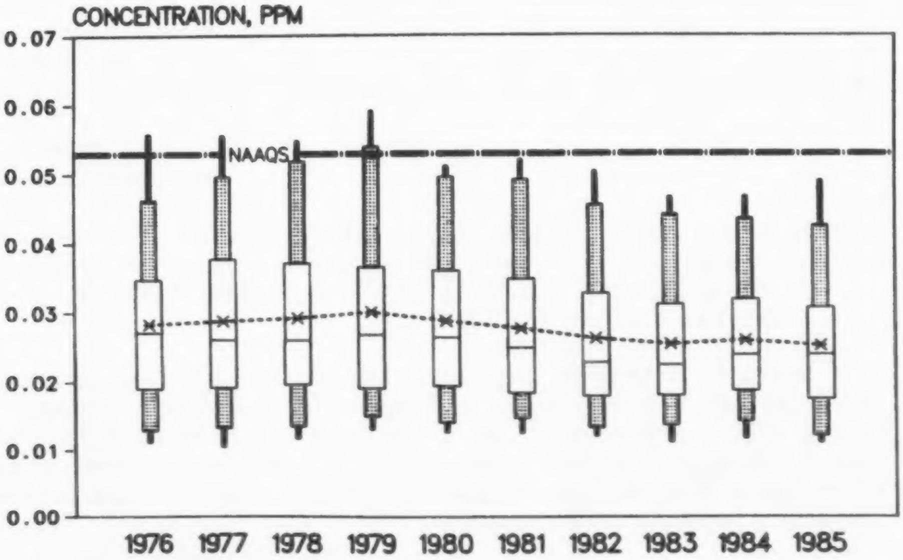

Figure 3-24. Boxplot comparisons of trends in annual mean nitrogen dioxide concentrations at 108 sites, 1976-1985.

In Figure 3-23, the 95 percent confidence intervals about the composite means allow for comparisons among the years. While there are no significant differences among the years for the NAMS, because there are so few sites meeting the historical trends criteria, there are significant differences among the composite means of the 108 long-term trends sites. Although the 1984 and 1985 composite mean NO_2 levels are not significantly different from one another, they are significantly less than the earlier years 1977 through 1980.

Long-term trends in NO_2 annual average concentrations are also displayed in Figure 3-24 with the use of boxplots. The improvement in the composite average between 1979 and 1985 can also be seen in the the upper percentiles. The lower percentiles show little change, however.

The trend in the estimated nationwide emissions of nitrogen oxides (NO_x) is similar to the NO_2 air quality trend. Table 3-4 shows NO_x emissions increasing from 1976 through 1978 and generally decreasing until 1984. Between 1976 and 1985 total nitrogen oxide emissions decreased by 1 percent, but highway vehicle emissions, the source category likely impacting the majority of urban NO_2 sites, decreased by 4 percent. Figure 3-25 shows that the two primary source categories of nitrogen oxide emissions are fuel combustion and transportation.

3.4.2 Five-year NO_2 Trends: 1981-85

Figure 3-26 uses the boxplot presentation to display recent trends in nitrogen dioxide annual mean concentrations for the years 1981-85. Focusing on the past five years, rather than the last ten years, more than doubles the number of sites, from 108 to 243, available for the analysis. Although the composite means from the recent period are lower than the long-term means, the trends are consistent for the two data bases.

The composite average NO_2 level at the 243 trend sites decreased 5 percent between 1981 and 1985. During this same period, nitrogen oxide emissions decreased by 1 percent. Between 1984 and 1985, the NO_2 composite average decreased 2 percent, while nitrogen oxide emissions recorded a 2 percent increase. This small year-to-year difference between the ambient and emissions percent change is likely not significant given the relatively low ambient NO_2 levels.

Regional trends in the composite average NO_2 concentrations for the years 1983-85 are displayed in Figure 3-27 using bar graphs. As indicated in the figure, Regions I and IX recorded the highest composite averages during the past 3 years. The pattern of the year-to-year changes is mixed among the regions, however, with seven of the ten regions showing decreases between 1984 and 1985.

Table 3-4. National Nitrogen Oxides Emission Estimates, 1976-1985.

(million metric tons/year)

Source Category	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Transportation	9.3	9.5	9.7	9.5	9.2	9.3	8.9	8.6	8.7	8.9
Fuel Combustion	10.0	10.4	10.3	10.5	10.1	10.0	9.8	9.6	10.2	10.2
Industrial Processes	0.7	0.7	0.8	0.8	0.7	0.6	0.5	0.5	0.6	0.6
Solid Waste	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Miscellaneous	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1
Total	20.3	21.0	21.1	21.0	20.3	20.3	19.5	19.1	19.7	20.0

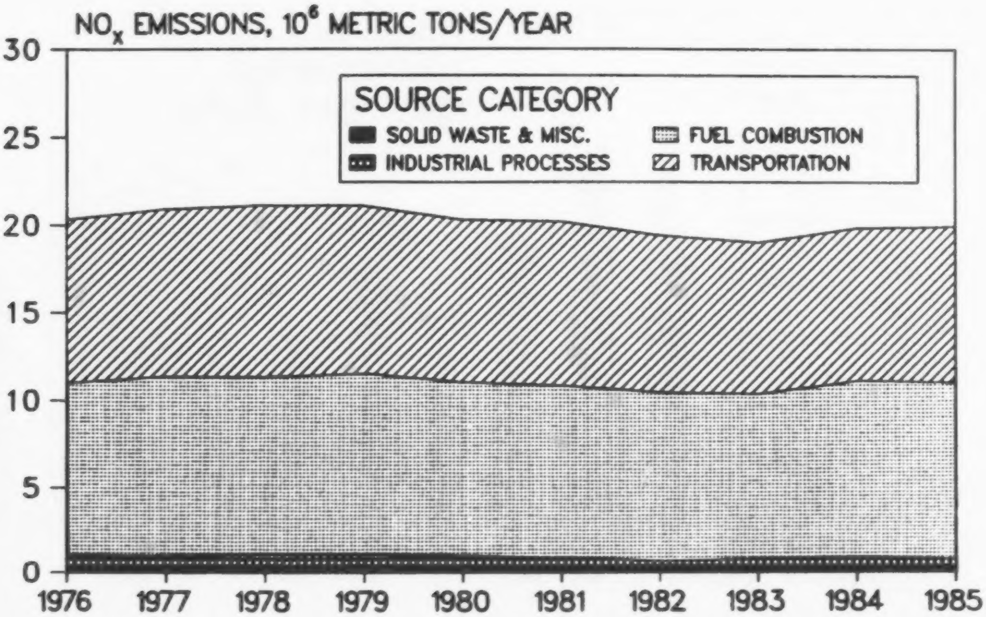

Figure 3-25. National trend in nitrogen oxides emissions, 1976-1985.

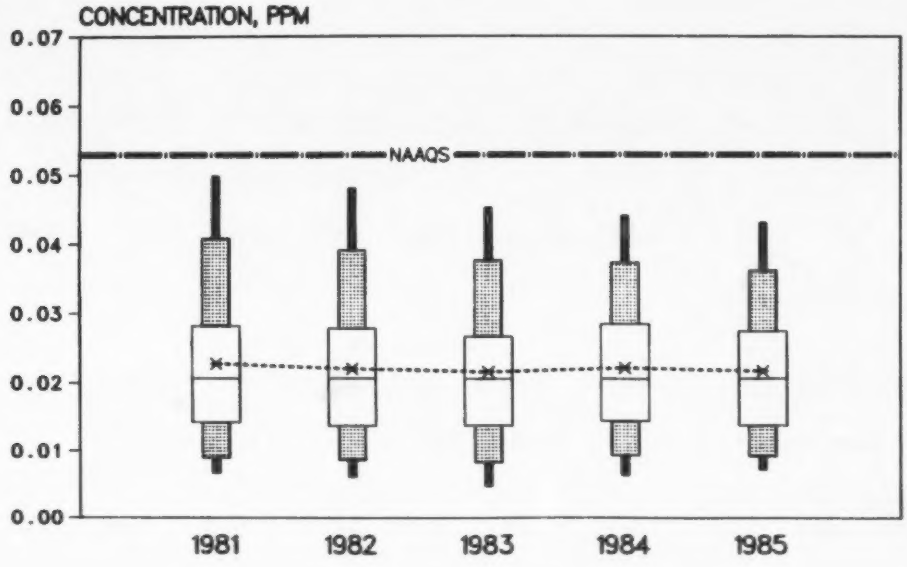

Figure 3-26. Boxplot comparisons of trends in annual mean nitrogen dioxide concentrations at 243 sites, 1981-1985.

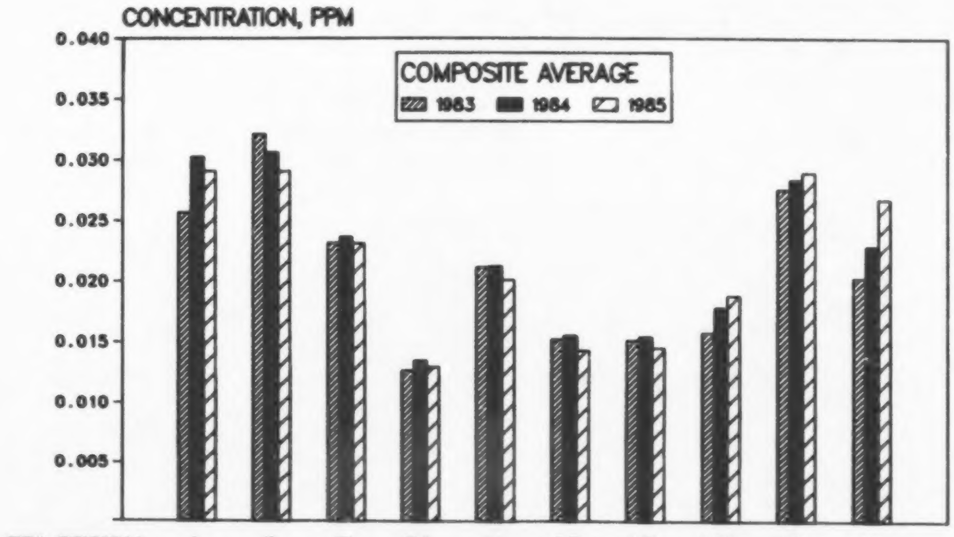

Figure 3-27. Regional comparison of 1983, 1984, 1985 composite average of the annual mean nitrogen dioxide concentration.

3.5 TRENDS IN OZONE

Ozone (O_3) continues to be a major concern for large urban areas throughout the nation. Ozone is not emitted directly by specific sources but is formed in the air by chemical reactions between nitrogen oxides and volatile organic compounds (VOC's) which come from sources such as gasoline vapors, chemical solvents, and combustion products of various fuels. These reactions are stimulated by sunlight and temperature so that peak ozone levels typically occur during the warmer times of the year. The strong seasonality of ozone levels makes it possible for areas to limit their ozone monitoring to a certain portion of the year, termed the ozone season. The length of the ozone season varies from one area of the country to another. May through October is typical but States in the south and southwest may monitor the entire year. More northern states would have shorter ozone seasons such as May through September for North Dakota. This analysis uses these ozone seasons on a State by State basis to ensure that the data completeness requirements are applied to the relevant portions of the year.

The O_3 NAAQS is defined in terms of the daily maximum, that is, the highest hourly average for the day, and specifies that the expected number of days per year with values greater than 0.12 ppm should not be greater than one. Both the annual second highest daily maximum and the number of daily exceedances during the ozone season are considered in this analysis.

The trends site selection process, discussed in Section 2.1, resulted in 183 sites being selected for the 1976-85 period and 523 sites qualifying for the 1981-85 5-year data base. Sixty-five of the long-term trends sites were NAMS while 196 NAMS sites were included in the 5-year trends data base. In both cases, the 5-year data base is about three times as large as the 10-year data base which reflects the improvement in ambient ozone monitoring networks.

3.5.1. Ten-Year Ozone Trends: 1976-85

Figure 3-28 displays the 10-year composite average trend for the second high day during the ozone season for the 183 trends sites and the subset of 65 NAMS sites. While the 1985 composite average for the 183 trend sites is 19 percent lower than the 1976 average, the interpretation of this decrease is complicated by a calibration change for ozone measurements that occurred in the 1978-79 time period.[17] The stippled portion of Figure 3-31 indicates data affected by measurements taken prior to the calibration change. This complication has been discussed in previous reports.[7,9] Part of the problem in quantifying exactly how much of the 1978-79 decrease is due to the calibration change is that not all agencies made the change at the same time and for some States the data prior to 1979 already accounted for the calibration change. Therefore, trend comparisons involving data prior to 1979 should be viewed with caution and an awareness of the possible effect of the calibration change. Comparing the 1985 and 1979 levels shows a 10 percent decrease in the composite average for all trend sites and also for the subset of NAMS.

The 10-year trend for the annual second highest daily maximum for the 183 site data base is displayed in Figure 3-29 using the boxplot presentation. Again, the pre-1979 values are affected by the calibration change, but the patterns from 1979 on are reasonably consistent across all percentiles. Perhaps the most obvious feature is that the 1979, 1980, and 1983 levels are similar and higher than those for 1981, 1982, 1984, and 1985. The 1985 levels are lower than those in the other years. Figure 3-30 presents the 1976-85 trend for the composite average number of ozone exceedances. This statistic is adjusted for missing data and reflects the number of days that the level of the ozone standard is exceeded during the ozone season. The stippled area again indicates the time period when comparisons would be affected by the calibration change so that the 63 percent decrease between 1976 and 1985 incorporates the effect of the calibration change. Between 1979 and 1985 the expected number of exceedances decreased 38 percent for the 183 sites with a 42 percent decrease for the subset of NAMS sites. As with the second maximum, the 1985 values are the lowest with the 1979, 1980, and 1983 values being higher than those for 1981, 1982, 1984, and 1985.

Table 3-5 and Figure 3-31 display the 1976-85 emission trends for volatile organic compounds (VOC) which, along with nitrogen oxides, are involved in the atmospheric chemical and physical processes that result in the formation of O_3. Total VOC emissions are estimated to have decreased 11 percent between 1976 and 1985.[8] As shown in Table 3-5, the annual total for each year of the 1980's is less than any of the annual totals for the 1976-79 period. Between 1976 and 1985, VOC emissions from transportation sources are estimated to have decreased 30 percent despite a 26 percent increase in vehicle miles of travel during this same time period. While most of the source categories showed long term improvement, the fuel combustion component increased. Fuel combustion accounted for 5 percent of the total VOC emissions in 1976 compared to 12 percent in 1985.

3.5.2 Five-Year Ozone Trends: 1981-85

By restricting the analysis to the 1981-85 time period, it is possible to expand the trends data base to include 523 sites. Figure 3-32 uses a boxplot presentation of the annual second maximum daily value at these sites. Although the national composite average decreased 5 percent between 1981 and 1985, the more obvious feature of this graph is that 1983 levels were much higher than those of the other four years. Previous reports[7,9] have discussed the likelihood that these higher

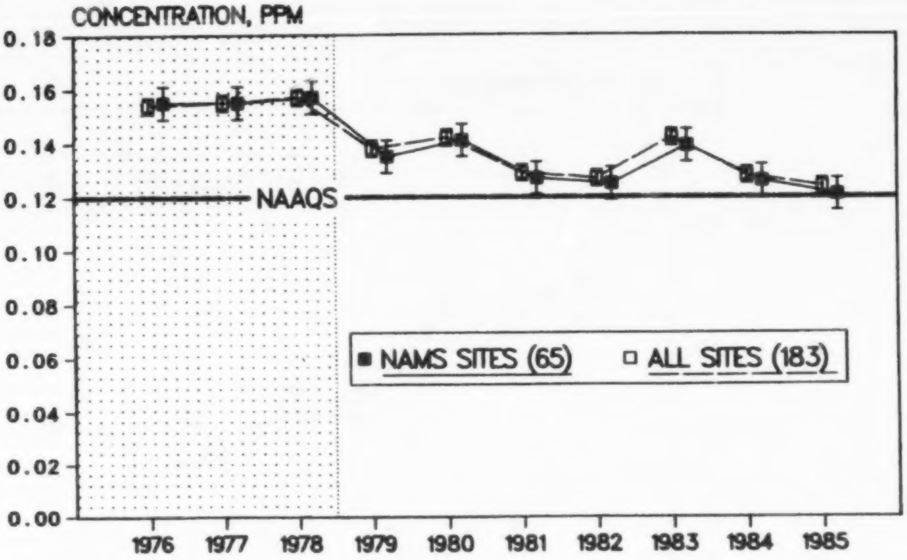

Figure 3-28. National trend in the composite average of the second highest maximum 1-hour ozone concentration at both NAMS and all sites with 95 percent confidence intervals, 1976-1985.

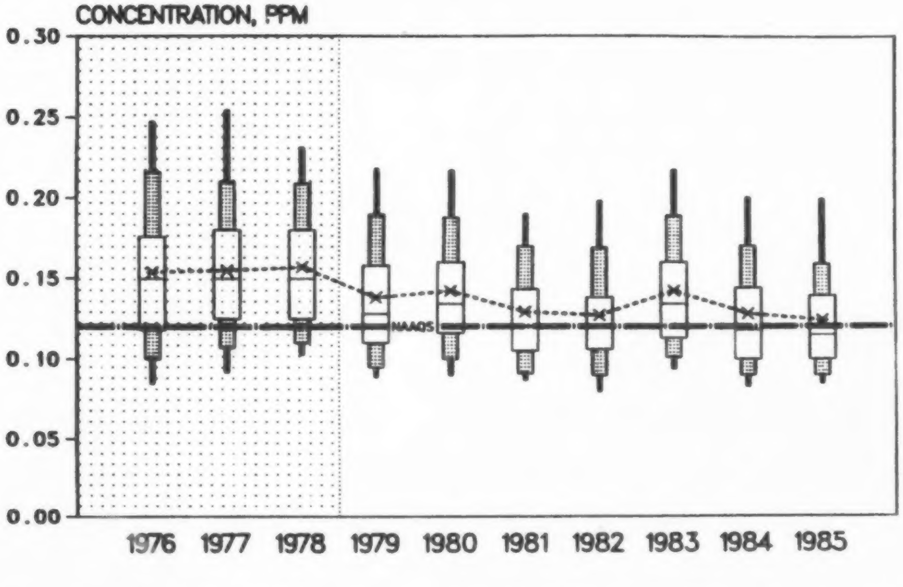

Figure 3-29. Boxplot comparisons of trends in annual second highest daily maximum 1-hour ozone concentration at 183 sites, 1976-1985.

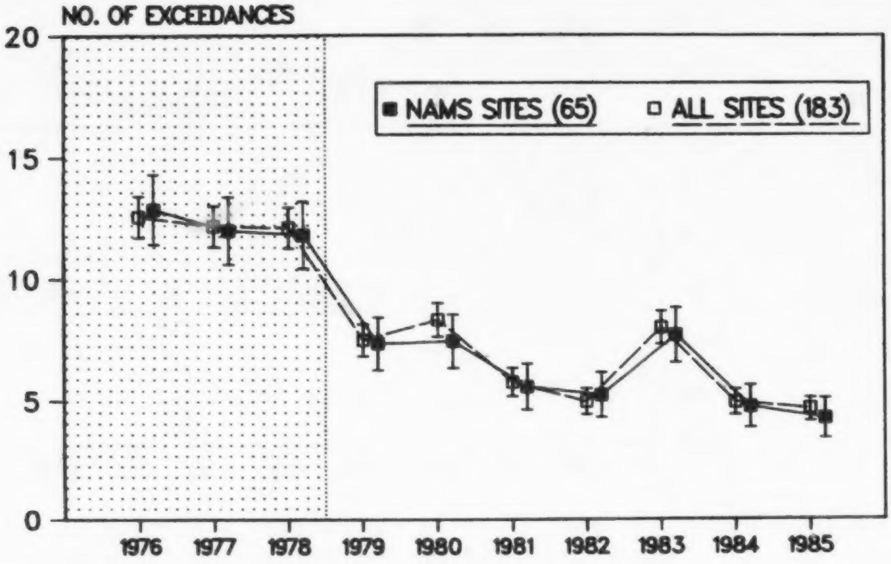

Figure 3-30. National trend in the composite average of the estimated number of daily exceedances of the ozone NAAQS in the ozone season at both NAMS and all sites with 95 percent confidence intervals, 1976-1985.

Table 3-5. National Volatile Organic Compound Emission Estimates, 1976-1985.

(million metric tons/year)

Source Category	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Transportation	10.3	10.0	9.7	8.9	8.2	7.9	7.4	7.3	7.3	7.2
Fuel Combustion	1.2	1.4	1.6	1.9	2.2	2.3	2.5	2.6	2.6	2.6
Industrial Processes	8.7	9.1	9.7	9.6	9.0	8.1	7.3	7.7	8.6	8.6
Non-Industrial Organic Solvent Use	1.9	1.9	1.9	2.0	1.9	1.6	1.5	1.6	1.8	1.6
Solid Waste	0.8	0.8	0.8	0.7	0.6	0.6	0.6	0.6	0.6	0.6
Miscellaneous	1.0	0.8	0.8	0.9	1.0	0.9	0.7	1.1	0.9	0.7
Total	24.0	23.9	24.5	24.1	22.8	21.5	20.0	20.8	21.8	21.3

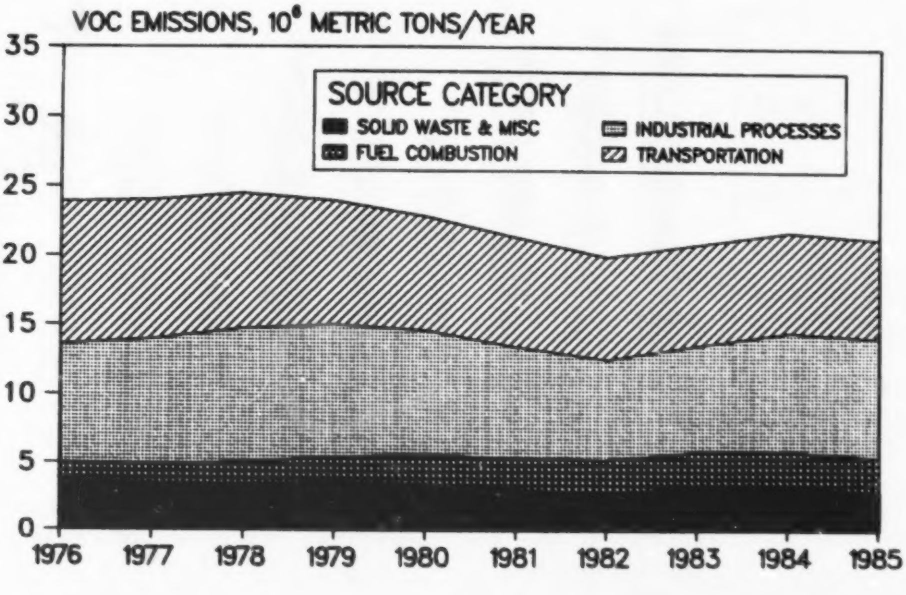

Figure 3-31. National trend in emissions of volatile organic compounds, 1976-1985.

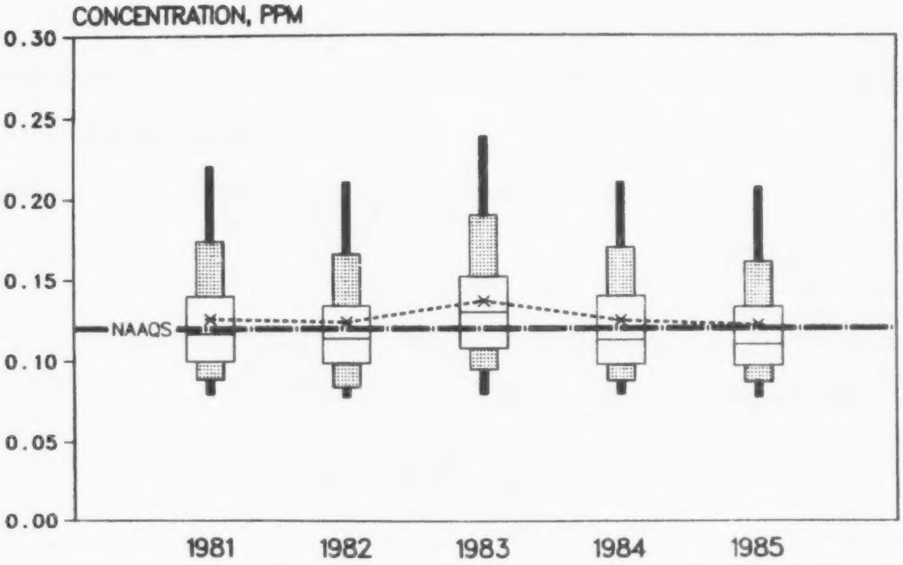

Figure 3-32. Boxplot comparisons of trends in annual second highest daily maximum 1-hour ozone concentrations at 523 sites, 1981-1985.

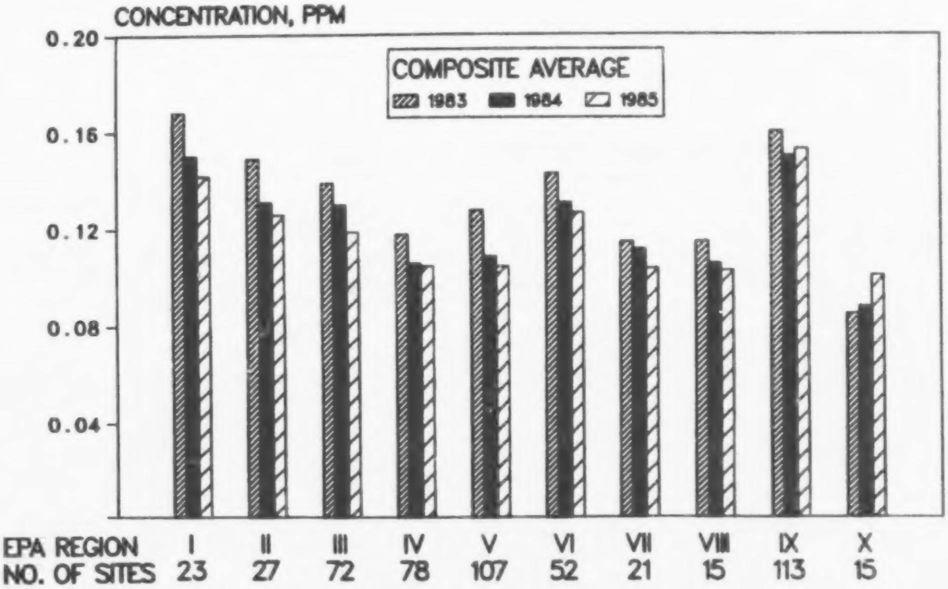

Figure 3-33. Regional comparison of the 1983, 1984, 1985 composite average of the second-highest daily 1-hour ozone concentrations.

1983 levels were influenced by meteorological conditions in that year that were more conducive to ozone formation than conditions in adjacent years. While 1985 levels are similar to 1984, there was a slight improvement of 2 percent in the national composite average between these 2 years.

As shown in Table 3-5, total VOC emissions are estimated to have decreased by only 1 percent between 1981 and 1985. Transportation sources decreased by 9 percent during this period. Between 1984 and 1985 both total VOC emissions and the transportation component showed a decrease of approximately 2 percent which is similar to the ambient air quality improvement.

Figure 3-33 presents a regional comparison for 1983, 1984, and 1985 of the composite average second highest daily maximum 1-hour ozone concentration. For nine of the ten EPA Regions, 1983 was the highest of these 3 years. The only exception to this pattern was in Region X, the northwest. The 1985 levels were also lower than those of 1984 for most parts of the country.

3.6 TRENDS IN LEAD

Lead (Pb) gasoline additives, non-ferrous smelters, and battery plants are the most significant contributors to atmospheric Pb emissions. Transportation sources in 1985 alone contribute about 73 percent of the annual emissions, down from 87 percent in 1984. The reasons for this drop are noted below.

Prior to promulgation of the Pb standard in October 1978,[18] two air pollution control programs were implemented by EPA that have resulted in lower ambient Pb levels. First, regulations were issued in the early 1970's which required the Pb content of all gasoline to be gradually reduced over a period of many years. Most recently the Pb content of leaded gasoline pool was to be reduced from an average of 1.0 grams/gallon to 0.5 grams/gallon on July 1, 1985 and still further to 0.1 grams/gallon on January 1, 1986. Second, as part of EPA's overall automotive emission control program, unleaded gasoline was introduced in 1975 for use in automobiles equipped with catalytic control devices which reduced emissions of carbon monoxide, hydrocarbons and nitrogen oxides. In 1985 unleaded gasoline sales accounted for 65 percent of the total gasoline market. Additionally, Pb emissions from stationary sources have been substantially reduced by control programs oriented toward attainment of the TSP and Pb ambient standards. The overall effect of these three control programs has been a major reduction in the amount of Pb in the ambient air.

3.6.1 Long-term Lead Trends: 1976-85

Previous trend analyses of ambient Pb data[19,20] were based almost exclusively on National Air Surveillance Network (NASN) sites. These sites were established in the 1960's to monitor ambient air quality levels of TSP and associated trace metals, including Pb. The sites were predominantly located in the central business districts of larger American cities. In September 1981, ambient Pb monitoring regulations were promulgated.[21] The siting criteria in the regulations resulted in the elimination of many of the old historic TSP monitoring sites as being unsuitable sites for the measurement of ambient Pb concentrations.

As with the other pollutants, the trend sites that were selected had to satisfy an annual data completeness criterion of at least 8 out of 10 years of data in the 1976 to 1985 time period. A year was included as "valid" if at least 3 of the 4 quarterly averages were available. A total of only 53 urban-oriented sites, representing nineteen states, met the data completeness criteria. Only seven of these sites were NAMS sites, thereby, making a NAMS trend determination tentative. Twenty-seven of the trend sites were located in the States of Arizona, Pennsylvania and Texas. A total of 241 sites satisfied a trend criteria for the 1981-85 period, which required 4 out of 5 years in the 1981 to 1985 time period.

The mean of the composite maximum quarterly averages and their respective 95 percent confidence intervals are shown in Figure 3-34 for both the 53 urban sites and 7 NAMS sites (1976-1985). There was a 79 percent overall (1976-85) decrease for the 53 urban sites. The confidence

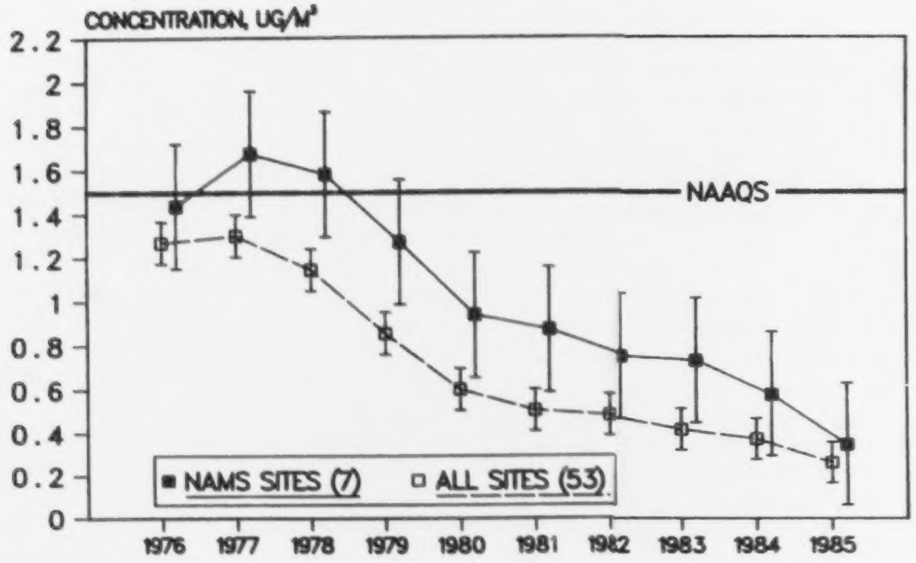

Figure 3-34. National trend in the composite average of the maximum quarterly average lead concentration at 53 sites and 7 NAMS sites (1976-1985) with 95 percent confidence intervals.

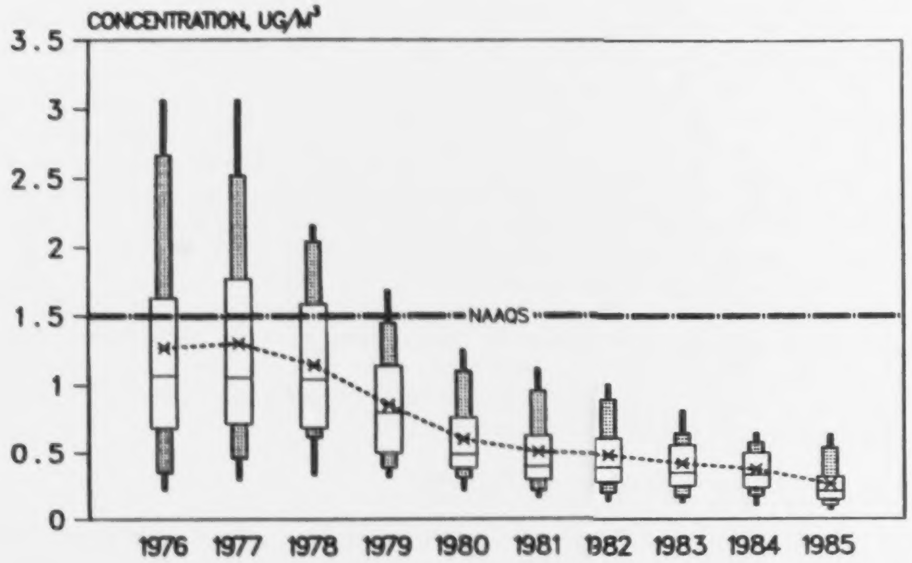

Figure 3-35. Boxplot comparisons of trends in maximum quarterly average lead concentrations at 53 sites, 1976-1985.

intervals for these sites indicate that the 1976-79 averages are significantly different from the 1980-85 averages. Moreover, the 1985 average is statistically different from all averages prior to 1983. The 1985 average percentage-wise shows a 32 percent decrease from 1984. This is the largest percentage decrease for any two consecutive years except for 1979-80 when the decrease also was 30 percent. The reduction of Pb in gasoline from 1.0 grams/gallon to 0.5 grams/gallon is probably the principal reason for this drop together with the increasing sales of unleaded gasoline. Because of the small number of NAMS sites (7) with 8 years of data, the confidence intervals are wide. However, the 1984 and 1985 averages are still significantly different from averages in the 1976-79 time period. Figure 3-35 shows boxplot comparisons of the maximum quarterly average Pb concentrations at the 53 urban oriented Pb trend sites (1976-85). This figure like the previous one shows the dramatic improvement in ambient Pb concentrations for the entire distribution of trend sites. Like the composite average concentration since 1977, most of the percentiles also show a monotonically decreasing pattern.

A slightly larger sample of 53 urban-oriented sites qualified as trend sites for the 1976-85 time period as compared with 36 sites for the 1975-84 time period in last year's report.[7] Because of the small number of 1976-85 trend sites relative to the 1981-85 trend sites more importance should be given to the 5-year (1981-85) trend.

The 1976-85 trends in total lead emissions based on information from the National Emissions Data System[8] is shown in Figure 3-36. Table 3-6 summarizes the Pb emissions data as well. The drop (1976-85) in Pb emissions was 86 percent. This compares with a 79 percent decrease (1976-85) in ambient Pb noted above. The drop in Pb consumption and subsequent Pb emissions since 1976 was brought about because of the increased use of unleaded gasoline in catalyst equipped cars and the reduced Pb content in leaded gasoline as noted above. The results of these reductions in 1985 amounted to a 48 percent reduction nationwide in total Pb emissions from 1984 levels. In 1985 unleaded gasoline sales represented 65 percent of the total gasoline sales. Although the good agreement between the trend in lead consumption, emissions, and ambient levels may be more fortuitous than real due to the imbalanced national sample of trend sites, it does show that ambient urban Pb levels are responding to the drop in lead emissions.

3.6.2 Recent Lead Trends: 1981-85

Ambient Pb trends were also studied over the shorter time period 1981-85 (Figure 3-37). A total of 241 urban sites from 43 states met the minimum data requirement of at least 4 out of the 5 years of data. This larger and more representative set of sites showed an improvement of 50 percent in average Pb concentrations over this time period. This corresponds to reductions in Pb emissions of 62 percent. Even this larger group of sites was disproportionately weighted by sites in California and Pennsylvania. These states accounted for 35 percent of the 241 sites represented.

Table 3.6. National Lead Emission Estimates, 1976-1985.

(thousand metric tons/year)

Source Category	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Transportation	132.4	124.2	112.4	94.6	59.4	46.4	46.9	40.7	34.7	15.4
Fuel Combustion	8.3	7.2	6.1	4.9	3.9	2.8	1.7	0.6	0.5	0.5
Industrial Processes	8.1	5.7	5.4	5.2	3.6	3.0	2.7	2.4	2.3	2.3
Solid Waste	4.3	4.1	4.0	4.0	3.7	3.7	3.1	2.6	2.6	2.8
Total	153.1	141.2	127.9	108.7	70.6	55.9	54.4	46.3	40.1	21.0

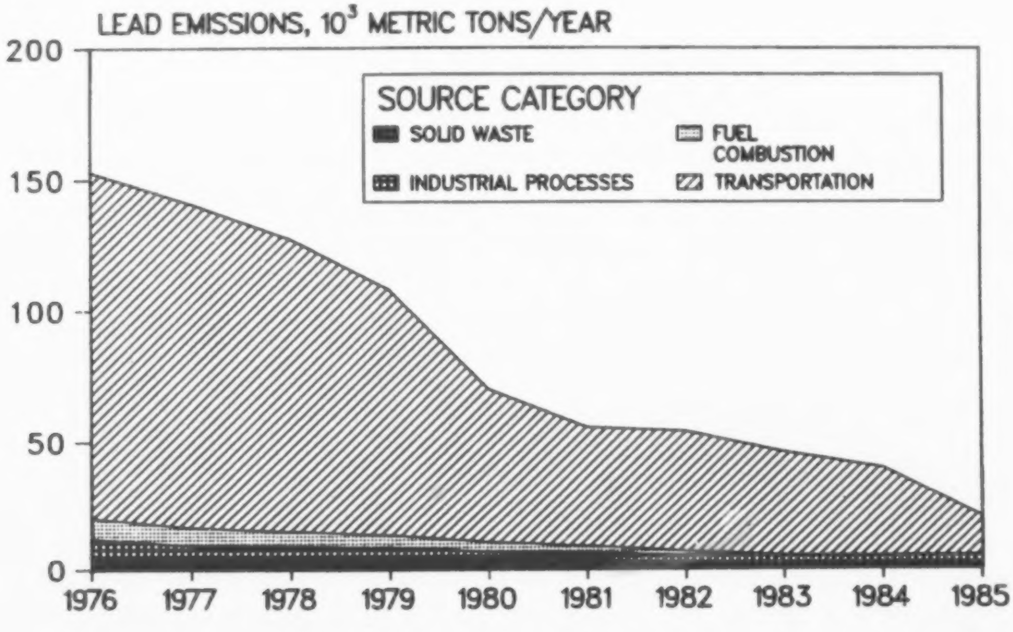

Figure 3-36. National trend in lead emissions, 1976-1985.

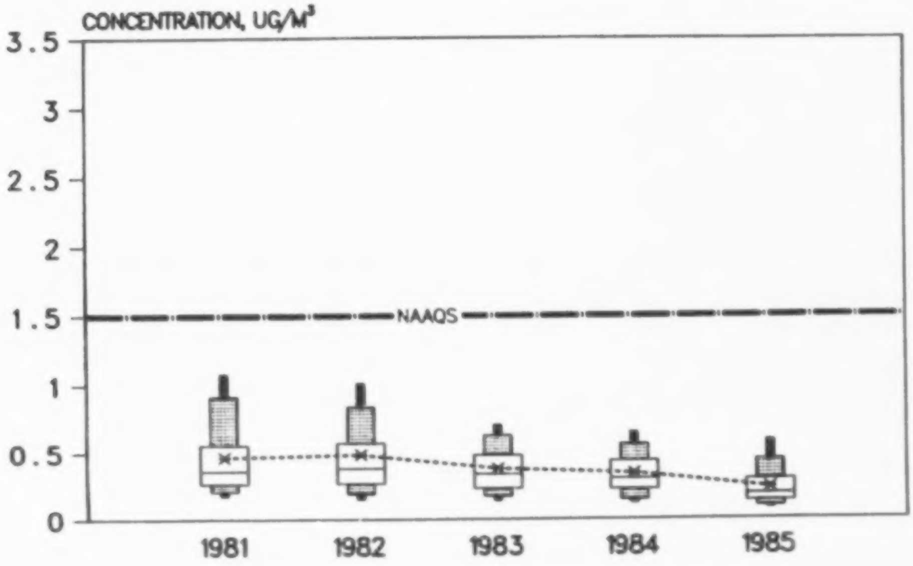

Figure 3-37. Boxplot comparisons of trends in maximum quarterly average lead concentrations at 241 sites, 1976-1985.

Figure 3-38 shows 1983, 84 and 85 composite average Pb concentrations by EPA region. The number of sites vary dramatically from 1 site in Region VIII to 68 sites in Region IX. Only in the case of Regions III, IV, V, VI, and IX can reasonable comparisons be made, since each region has at least 19 sites. The 1983 and 1984 levels are fairly comparable between these five regions with slightly higher Pb averages in Regions IV and VI followed by Region V, Region IX and lower levels in Region III.

The sites in Region III represent more of a cross section of the entire region, that is smaller cities which account for its lower Pb levels. Another point to note from this figure is that all regions show the expected improvement in Pb concentrations over the 1983-85 time period. For the eight regions with 10 or more sites there is improvement in each of the 3 years with the exception of Region III where the 1983 and 1984 means are the same, and Region II where the 1984 average is slightly higher than in 1983.

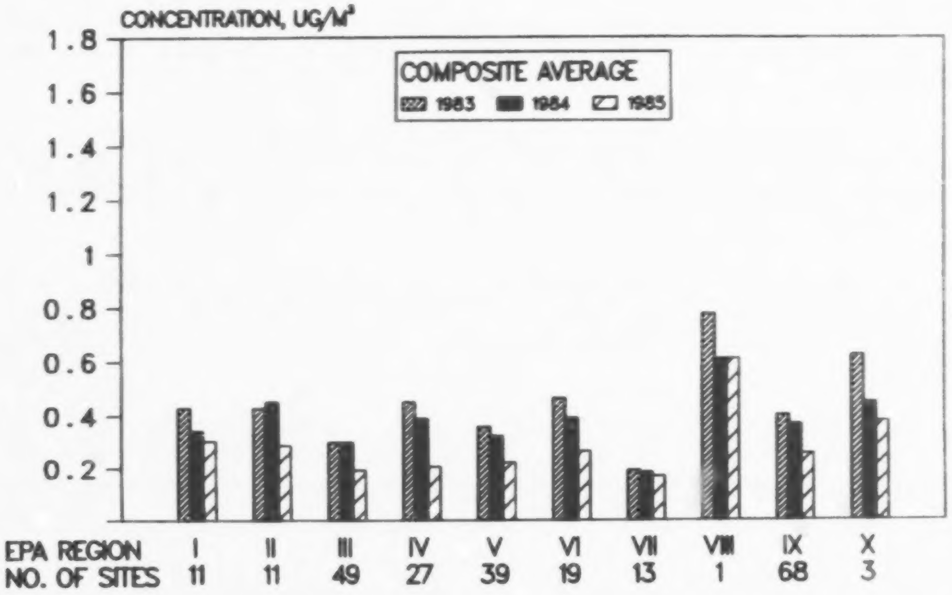

Figure 3-38. Regional comparison of the 1983, 1984, 1985 composite average of the maximum quarterly average lead concentration.

3.7 REFERENCES

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4. AIR QUALITY LEVELS IN METROPOLITAN STATISTICAL AREAS

The Tables in this section summarize air quality levels by Metropolitan Statistical Area (MSA) for MSA's with 1984 populations greater than 500,000. These summaries are complemented with an analysis of the number of people living in counties in which pollutant specific primary health NAAQS(s) (Table 4-1) were exceeded by measured air quality in 1985 (Figure 4-1). Clearly, O_3 is the most pervasive air pollution problem in 1985 in the United States with an estimated 76.4 million people living in counties which exceeded the O_3 standard. TSP follows with 47.8 million people, CO with 39.6 million people, NO_2 with 7.5 million people, lead with 4.5 million people and SO_2 with 2.2 million people.

In the MSA summary tables which follow, the air quality statistics relate to pollutant-specific NAAQS. The purpose of these summaries is to provide the reader with information on how air quality varies among MSA's and from year-to-year. The higher air quality levels measured in the MSA are summarized for the years 1983, 1984 and 1985.

The reader is cautioned that these summaries are not sufficient in themselves to adequately rank or compare the SMSA's according to their air quality. To properly rank the air pollution severity in different MSA(s), data on population characteristics, daily population mobility, transportation patterns, industrial composition, emission inventories, meteorological factors and, most important, the spatial representativeness of the monitoring sites would also be needed.

The same annual data completeness criterion used in the air quality trends data base was used here for the calculation of annual means. (See Section 2.1). If some data have been collected at one or more sites, but none of these sites meet the annual data completeness criteria, then the reader will be advised that there are insufficient data to calculate the annual mean.

With respect to the summary statistics for air quality levels with averaging times less than or equal to 24-hours, measured with continuous monitoring instruments, a footnote will be placed next to the level if the volume of annual data is less than 4380 hours for CO, less than 183 days for SO_2 or less than 50 percent of the days during the ozone season for ozone, which varies by State.[1] For example, in California the ozone season is defined as 12 months, January through December, while in New Jersey it is defined as 7 months, April through October.

4.1 SUMMARY STATISTICS

In the following MSA summaries, the air quality levels reported are the highest levels measured within the MSA(s). All available sites in an MSA are used in these summaries. In the case of O_3, the problem as stated

Table 4-1. Air Quality Summary Statistics and Their Associated National Ambient Air Quality Standards (NAAQS)

POLLUTANT	STATISTICS	PRIMARY NAAQS
Total Suspended Particulate	annual geometric mean	75 ug/m3
Sulfur Dioxide	annual arithmetic mean	0.03 ppm
	second highest 24-hour average	0.14 ppm
Carbon Monoxide	second highest nonoverlapping 8-hour average	9 ppm
Nitrogen Dioxide	annual arithmetic mean	0.053 ppm
Ozone	second highest daily maximum 1-hour average	0.12 ppm
Lead	maximum quarterly average	1.5 ug/m3

ug/m3 = micrograms per cubic meter
ppm = parts per million

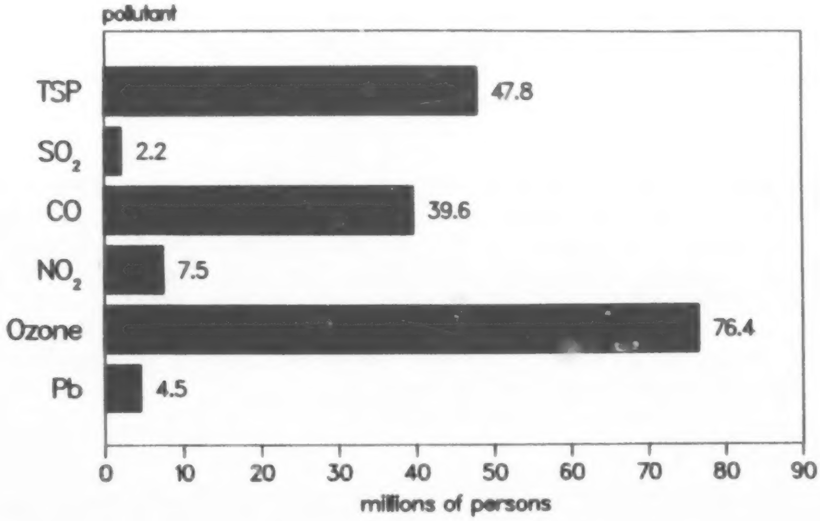

Figure 4-1. Number of persons living in counties with air quality levels above the primary national ambient air quality standards in 1985 (based on 1980 population data).

earlier is pervasive and the high values associated with the pollutant can reflect a large part of the MSA. However, in many cases peak ozone concentrations occur downwind of major urban areas, e.g. peak ozone levels attributed to the Chicago metropolitan area are recorded in and near Racine, Wisconsin. In contrast, the high CO values are generally highly localized and reflect downtown areas with heavy traffic. The scale of measurement for the pollutants - TSP, SO_2 and NO_2 - fall somewhere in between. Finally, while lead measurements generally reflect lead concentrations near roadways in the MSA, if the monitor is located near a point source of lead emissions it can produce readings substantially higher. Such is the case in several MSAs. If the lead monitor is located near a point source it will be footnoted accordingly in Table 4-8.

The pollutant-specific statistics reported are summarized in Table 4-1, along with their associated primary NAAQS concentrations. For example, if an MSA has three ozone monitors in 1985 with second highest daily hourly maxima of .15 ppm, .14 ppm and .12 ppm, the highest of these, .15 ppm, would be reported for that MSA for 1985.

In the case of Pb, the quarterly average is based either on as many as 90 24-hour measurements or one or more chemical composite measurements.* Most of the maximum quarterly Pb averages are based on multiple 24-hour measurements. If the maximum quarterly average is based on a chemical composite, it is footnoted accordingly.

4.2 AIR QUALITY MSA COMPARISONS

In each of the following MSA air quality summaries, the MSA's are grouped according to population starting with the largest MSA - New York, NY-NJ and continuing to the smallest MSA with a population in excess of 500,000, New Haven-Meriden, Connecticut. The population groupings and the number of MSA's contained within each are as follows: 17 MSA's have populations in excess of 2 million, 27 MSA's have populations between 1 and 2 million and 45 MSA's have populations between 0.5 and 1 million. The population statistics are based on the 1984 Metropolitan Statistical Areas estimates.[2]

Air quality maps of the United States are introduced to show at a glance how air quality varies among the 89 MSA's. Figures 4-2 through 4-7 appear just before the appropriate table summarizing the same air pollution specific statistic. In each map, a spike is plotted at the city location on the map surface. This represents the highest pollutant concentration, recorded in 1985, corresponding to the appropriate air quality standard. Each spike is also projected onto a backdrop facilitating comparison with the level of the standard. This also provides an east-west profile of concentration variability throughout the country.

The air quality summary statistics are summarized in the following figures and tables:

*A chemical composite measurement can be either a measurement for an entire month or an entire quarter.

Figure 4-2. United States Map of the Highest Annual Geometric Mean Suspended Particulate Concentration by MSA. The map for particulate matter displays the maximum annual geometric mean TSP concentration in 1985 for large metropolitan areas. The highest concentrations are generally found in the industrial Midwest and arid areas of the West. The east-west profile shows that levels above the current standard of 75 ug/m^3 can be found throughout the Nation.

Table 4-2. Highest Annual Geometric Mean Suspended Particulate Concentration by MSA, 1983-85.

Figure 4-3. United States Map of the Highest Annual Arithmetic Mean Sulfur Dioxide Concentration by MSA, 1985. The map for sulfur dioxide shows maximum annual mean concentrations in 1985. Among these large metropolitan areas, the higher concentrations are found in the heavily populated Midwest and Northeast. The peak SO_2 mean concentration occurs in Pittsburgh, PA at an individual site near a large steel complex, however, all urban areas have ambient air quality concentrations lower than the current annual standard of 80 ug/m^3 (.03 ppm). Because this map only represents areas with population greater than one half million, it does not reflect air quality in the vicinity of smelters or large power plants in rural areas.

Table 4-3. Highest Annual Arithmetic Mean Sulfur Dioxide Concentration by MSA, 1983-85.

Figure 4-4. United States Map of the Highest Second Maximum 24-hour Average Sulfur Dioxide Concentration by MSA, 1985. The map for sulfur dioxide shows the highest second highest maximum 24-hour average sulfur dioxide concentration by MSA in 1985. The highest concentration is found in the Syracuse, NY MSA at a large chemical plant located in Solvay, NY. The second highest concentrations occur in Pittsburgh, PA at an individual site near a large steel company. Both concentrations exceed the level of the short-term standard. All other urban areas have lower ambient concentrations below the 24-hour NAAQS of 0.14 parts per million.

Table 4-4. Highest Second Maximum 24-hour Average Sulfur Dioxide Concentration by MSA, 1983-85.

Figure 4-5. United States Map of the Highest Second Maximum Nonoverlapping 8-hour Average Carbon Monoxide Concentration by MSA, 1985. The map for carbon monoxide shows peak metropolitan concentrations in terms of the second highest annual 8-hour value recorded in 1985. The east-west profile indicates that many of these urban areas in all geographic regions have air quality at or exceeding the 9 ppm level of the standard.

Table 4-5. Highest Second Maximum Nonoverlapping 8-hour Average Carbon Monoxide Concentration by MSA, 1983-85.

Figure 4-6. United States Map of the Highest Annual Arithmetic Mean Nitrogen Dioxide Concentration by MSA, 1985. The map for nitrogen dioxide displays the maximum annual mean measured in the Nation's largest metropolitan areas during 1985. Los Angeles, California is the only area in the country exceeding the air quality standard of .053 ppm.

Table 4-6. Highest Annual Arithmetic Mean Nitrogen Dioxide Concentration by MSA, 1983-85.

Figure 4-7. United States Map of the Highest Second Daily Maximum 1-hour Average Ozone Concentrations by MSA, 1985. The ozone map shows the second highest daily maximum concentration in the 89 largest metropolitan areas. As shown, slightly over half of these areas did not meet the 0.12 ppm standard in 1985. The highest concentrations are observed in Southern California, but high levels also persist in the Texas Gulf Coast, Northeast Corridor, and other heavily populated regions.

Table 4-7. Highest Second Daily Maximum 1-hour Average Ozone Concentration by MSA, 1983-85.

Figure 4-8. United States Map of the Highest Maximum Quarterly Average Lead Concentration by MSA, 1985. The map for lead displays maximum quarterly average concentrations in the Nation's largest metropolitan areas. The highest concentrations are found throughout the country in cities containing nonferrous smelters or other point sources of lead. Because of the switch to unleaded gasoline, other areas, primarily affected by automotive lead emissions, show levels below the current standard of 1.5 ug/m^3.

Table 4-8. Highest Maximum Quarterly Average Lead Concentration by MSA, 1983-85.

The air quality summaries follow:

4.3 REFERENCES

1. Federal Register, Vol. 51, No. 53, March 19, 1986.

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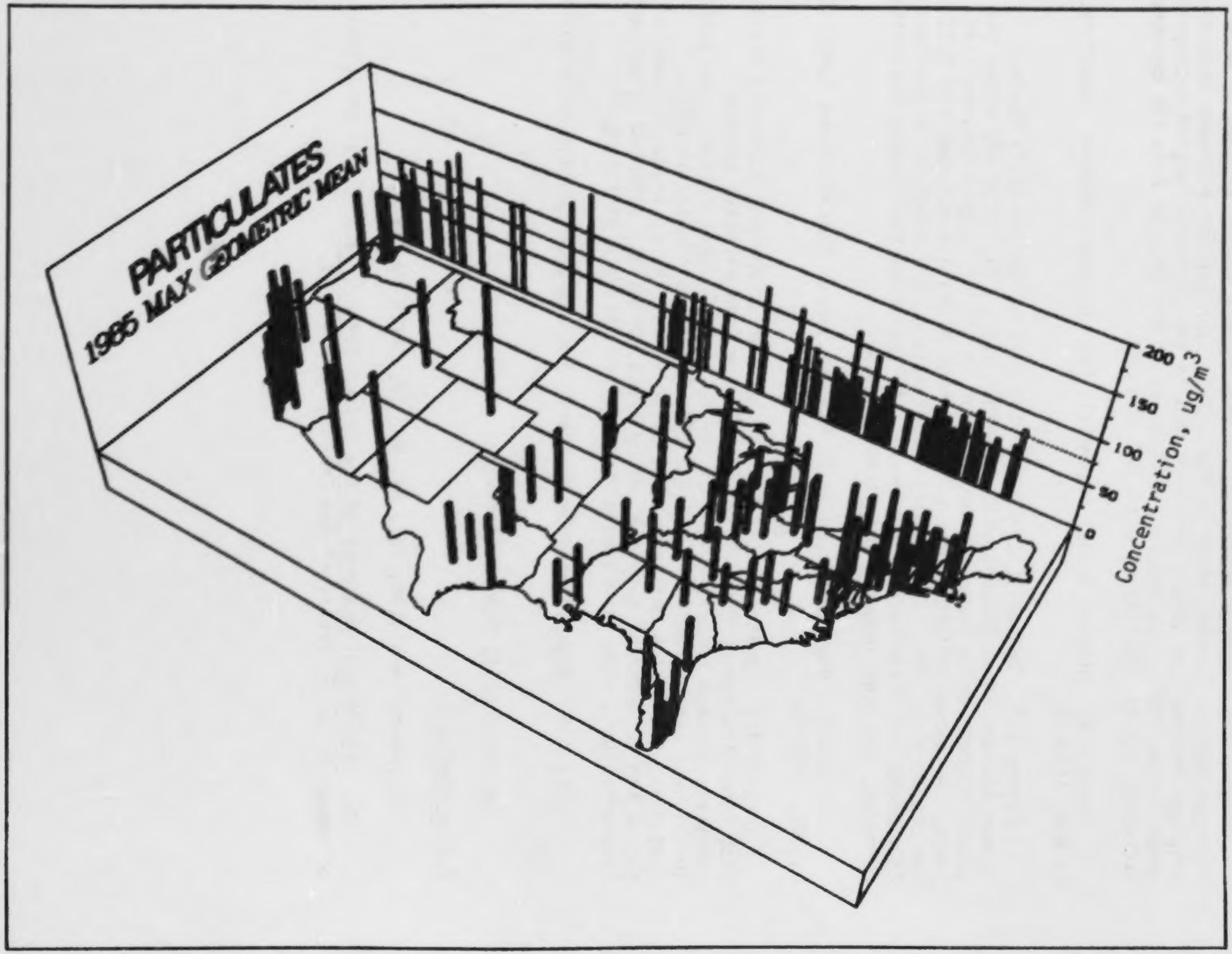

Figure 4-2. United States map of the highest annual geometric mean suspended particulate concentration by MSA, 1985.

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SUSPENDED PARTICULATE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 1

METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1983	1984	1985
POPULATION: > 2 MILLION			
NEW YORK, NY	59	64	70
LOS ANGELES-LONG BEACH, CA	86	108	119
CHICAGO, IL	93	85	85
PHILADELPHIA, PA-NJ	68	73	63
DETROIT, MI	101	106	112
WASHINGTON, DC-MD-VA	66	70	67
HOUSTON, TX	100	94	81
BOSTON, MA	69	58	81
NASSAU-SUFFOLK, NY	44	49	48
ST. LOUIS, MO-IL	134	119	120
ATLANTA, GA	60	72	60
MINNEAPOLIS-ST. PAUL, MN-WI	72	75	73
BALTIMORE, MD	76	88	77

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SUSPENDED PARTICULATE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 2

METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST 1983	ANNUAL GEOMETRIC MEAN 1984	1985
POPULATION: > 2 MILLION (CONT)			
DALLAS, TX	69	70	68
PITTSBURGH, PA	77	83	78
ANAHEIM-SANTA ANA, CA	83	97	92
SAN DIEGO, CA	70	74	80

TOTAL MSA'S > 2 MILLION : 17

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA

IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SUSPENDED PARTICULATE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 3

METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1983	1984	1985
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	73	73	81 *
OAKLAND, CA	46	57	57
CLEVELAND, OH	96	116	95
RIVERSIDE-SAN BERNARDINO, CA	110	133	133
TAMPA-ST. PETERSBURG-CLEARWATER, FL	59	68	64
PHOENIX, AZ	107	120	115
MIAMI-HIALEAH, FL	54	50	73
SEATTLE, WA	72	68	77
DENVER, CO	150	142	144
SAN FRANCISCO, CA	55	60	62
SAN JUAN, PR	73	77	82
KANSAS CITY, MO-KS	70	69	70
CINCINNATI, OH-KY-IN	80	70	64

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
* = THIS LEVEL REFLECTS TEMPORARY LOCAL CONSTRUCTION ACTIVITY.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SUSPENDED PARTICULATE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 4

METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1983	1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
MILWAUKEE, WI	60	58	57
SAN JOSE, CA	55	79	94
NEW ORLEANS, LA	70	64	61
BERGEN-PASSAIC, NJ	60	54	52
COLUMBUS, OH	68	72	63
NORFOLK-VIRGINIA BEACH-NEWPORT NEWS, VA	51	57	53
SACRAMENTO, CA	52	65	68
INDIANAPOLIS, IN	70	69	76
SAN ANTONIO, TX	69	66	67
FORT WORTH-ARLINGTON, TX	70	74	70
PORTLAND, OR-WA	82	80	97
FORT LAUDERDALE-HOLLYWOOD-POMPANO BEACH, FL	41	48	43
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	54	67	56

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SUSPENDED PARTICULATE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 5

METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1983	1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
SALT LAKE CITY-OGDEN, UT	57	100	97
TOTAL MSA'S 1 - 2 MILLION : 27			

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SUSPENDED PARTICULATE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 6

METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST 1983	ANNUAL GEOMETRIC MEAN 1984	1985
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	49	50	43
BUFFALO, NY	66	54	50
OKLAHOMA CITY, OK	67	60	61
LOUISVILLE, KY-IN	70	82	66
MEMPHIS, TN-AR-MS	78	70	55
DAYTON-SPRINGFIELD, OH	63	59	60
MIDDLESEX-SOMERSET-HUNTERDON, NJ	57	59	68
MONMOUTH-OCEAN, NJ	45	45	42
BIRMINGHAM, AL	88	98	85
NASHVILLE, TN	73	69	66
GREENSBORO-WINSTON SALEM-HIGH POINT, NC	56	57	57
ALBANY-SCHENECTADY-TROY, NY	51	60	59
ORLANDO, FL	47	48	43

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SUSPENDED PARTICULATE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 7

METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	50	48	52
RICHMOND-PETERSBURG, VA	58	51	47
JACKSONVILLE, FL	56	62	57
HARTFORD, CT	47	48	60
SCRANTON-WILKES-BARRE, PA	47	55	51
TULSA, OK	83	72	81
WEST PALM BEACH-BOCA RATON-DELRAY BEACH, FL	43	47	37
SYRACUSE, NY	64	68	61
AKRON, OH	60	55	50
ALLENTOWN-BETHLEHEM, PA-NJ	57	74	70
AUSTIN, TX	54	51	49
GARY-HAMMOND, IN	83	88	112
GRAND RAPIDS, MI	52	52	44

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SUSPENDED PARTICULATE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 8

METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
PROVIDENCE, RI	57	53	61
TOLEDO, OH	60	60	55
RALEIGH-DURHAM, NC	46	48	47
OMAHA, NE-IA	65	74	65
TUCSON, AZ	105	92	102
GREENVILLE-SPARTANBURG, SC	53	51	43
KNOXVILLE, TN	61	62	57
OXNARD-VENTURA, CA	58	77	67
HARRISBURG-LEBANON-CARLISLE, PA	51	59	49
FRESNO, CA	83	103	111
JERSEY CITY, NJ	78	79	81
WILMINGTON, DE-NJ-MD	68	46	47
BATON ROUGE, LA	55	54	49

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SUSPENDED PARTICULATE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 9

METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
LAS VEGAS, NV	89	101	113
EL PASO, TX	111	122	127
YOUNGSTOWN-WARREN, OH	75	64	66
TACOMA, WA	66	69	83
SPRINGFIELD, MA	49	49	54
NEW HAVEN-MERIDEN, CT	49	45	49

TOTAL MSA'S .5 - 1 MILLION : 45

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
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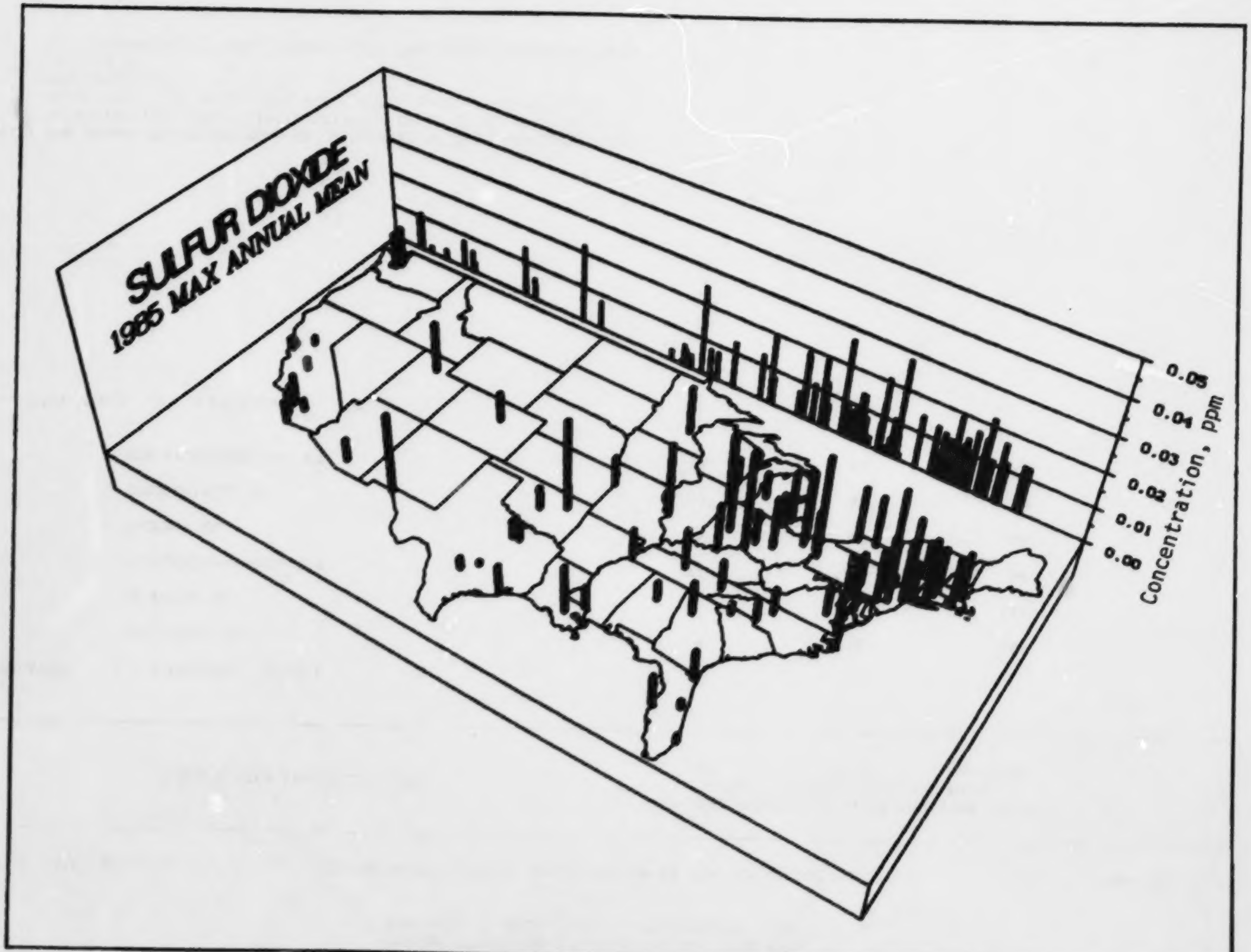
SULFUR DIOXIDE
1985 MAX ANNUAL MEAN
0.05
0.04
0.03
0.02
0.01
0.00
Concentration, ppm

Figure 4-3. United States map of the highest annual arithmetic mean sulfur dioxide concentration by MSA, 1985.

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: > 2 MILLION			
NEW YORK, NY	.024	.024	.022
LOS ANGELES-LONG BEACH, CA	.010	.011	.008
CHICAGO, IL	.014	.017	.019
PHILADELPHIA, PA-NJ	.016	.019	.017
DETROIT, MI	.015	.014	.014
WASHINGTON, DC-MD-VA	.013	.014	.013
HOUSTON, TX	.008	.010	.008
BOSTON, MA	.019	.016	.013
NASSAU-SUFFOLK, NY	.011	.013	.011
ST. LOUIS, MO-IL	.021	.021	.022
ATLANTA, GA	.010	.009	.009
MINNEAPOLIS-ST. PAUL, MN-WI	.011	.012	.013
BALTIMORE, MD	.015	.015	.012

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: > 2 MILLION (CONT)			
DALLAS, TX	.004	.005	.004
PITTSBURGH, PA	.043	.035	.028
ANAHEIM-SANTA ANA, CA	.006	.007	.006
SAN DIEGO, CA	.004	.005	.006
TOTAL SMSA'S > 2 MILLION : 17			

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.014	.015	.016
OAKLAND, CA	.002	.002	.002
CLEVELAND, OH	.019	.022	.019
RIVERSIDE-SAN BERNARDINO, CA	.003	.003	.003
TAMPA-ST. PETERSBURG-CLEARWATER, FL	.007	.006	.008
PHOENIX, AZ	.004	IN	IN
MIAMI-HIALEAH, FL	.002	IN	IN
SEATTLE, WA	.013	.011	.011
DENVER, CO	.013	.011	.009
SAN FRANCISCO, CA	.003	.006	.003
SAN JUAN, PR	ND	ND	ND
KANSAS CITY, MO-KS	.011	.014	.010
CINCINNATI, OH-KY-IN	.014	.025	.027

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
MILWAUKEE, WI	.010	.009	.007
SAN JOSE, CA	ND	ND	ND
NEW ORLEANS, LA	.007	.006	.006
BERGEN-PASSAIC, NJ	.015	.016	.015
COLUMBUS, OH	.015	.017	.014
NORFOLK-VIRGINIA BEACH-NEWPORT NEWS, VA	.011	.010	.010
SACRAMENTO, CA	.002	.002	.002
INDIANAPOLIS, IN	.016	.017	.019
SAN ANTONIO, TX	.004	.002	.003
FORT WORTH-ARLINGTON, TX	.005	.003	.005
PORTLAND, OR-WA	.007	.007	IN
FORT LAUDERDALE-HOLLYWOOD-POMPANO BEACH, FL	IN	ND	ND
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	.009	.014	.005

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
SALT LAKE CITY-OGDEN, UT	.010	.010	.010
TOTAL SMSA'S 1 - 2 MILLION : 27			

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 6

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.012	.015	.014
BUFFALO, NY	.016	.016	.015
OKLAHOMA CITY, OK	IN	IN	.006
LOUISVILLE, KY-IN	.014	.015	.013
MEMPHIS, TN-AR-MS	.008	.013	.008
DAYTON-SPRINGFIELD, OH	.009	.010	.009
MIDDLESEX-SOMERSET-HUNTERDON, NJ	.013	.016	.011
MONMOUTH-OCEAN, NJ	.010	ND	ND
BIRMINGHAM, AL	IN	ND	.005
NASHVILLE, TN	.011	.011	.011
GREENSBORO-WINSTON SALEM-HIGH POINT, NC	.008	.008	.007
ALBANY-SCHENECTADY-TROY, NY	.016	.014	.010
ORLANDO, FL	.002	.002	.002

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 7

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	.003	.006	.006
RICHMOND-PETERSBURG, VA	.008	.008	.007
JACKSONVILLE, FL	.008	.007	.008
HARTFORD, CT	.012	.012	.009
SCRANTON-WILKES-BARRE, PA	.011	.012	.012
TULSA, OK	.009	.019	.025
WEST PALM BEACH-BOCA RATON-DELRAY BEACH, FL	.001	.003	.002
SYRACUSE, NY	.010	.013	.019
AKRON, OH	.016	.017	.021
ALLENTOWN-BETHLEHEM, PA-NJ	.013	.015	.011
AUSTIN, TX	.009	.003	.001
GARY-HAMMOND, IN	.015	.016	.018
GRAND RAPIDS, MI	.006	.005	.007

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 8

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
PROVIDENCE, RI	.011	.013	.013
TOLEDO, OH	.010	.010	.009
RALEIGH-DURHAM, NC	ND	ND	ND
OMAHA, NE-IA	IN	.003	IN
TUCSON, AZ	.003	.010	.006
GREENVILLE-SPARTANBURG, SC	.004	IN	.003
KNOXVILLE, TN	.006	.007	.008
OXNARD-VENTURA, CA	.002	.002	IN
HARRISBURG-LEBANON-CARLISLE, PA	.009	.010	.009
FRESNO, CA	.006	.003	.003
JERSEY CITY, NJ	.015	.016	.015
WILMINGTON, DE-NJ-MD	.018	.018	.014
BATON ROUGE, LA	.012	.008	.013

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 9

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
LAS VEGAS, NV	ND	ND	ND
EL PASO, TX	.031	.025	.022
YOUNGSTOWN-WARREN, OH	.011	.011	.011
TACOMA, WA	.012	.011	.010
SPRINGFIELD, MA	.011	.012	.012
NEW HAVEN-MERIDEN, CT	.012	.013	.017

TOTAL SMSA'S .5 - 1 MILLION : 45

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
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B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

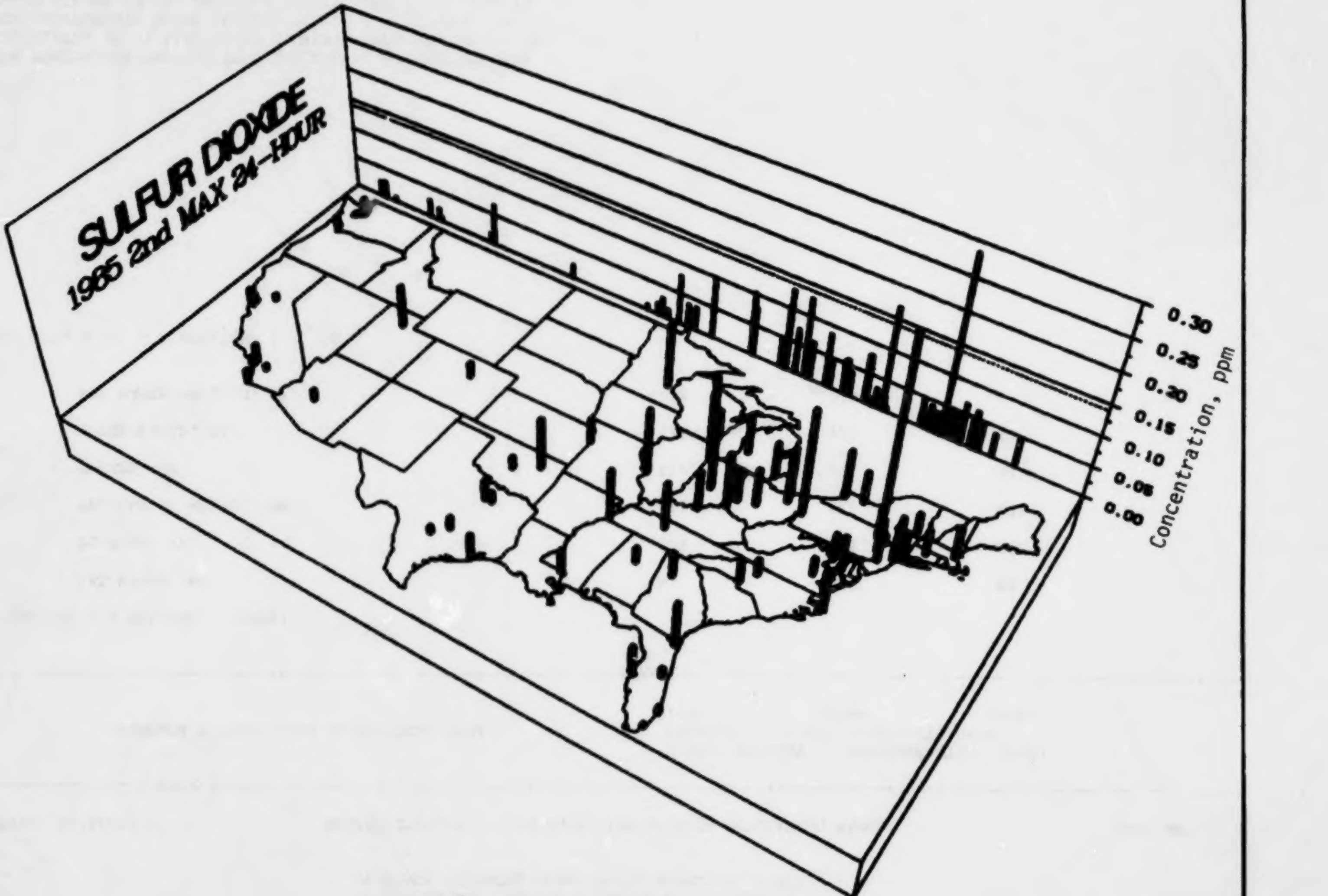
SULFUR DIOXIDE
1985 2nd MAX 24-HOUR
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Concentration, ppm

Figure 4-4. United States map of the highest second maximum 24-hour average sulfur dioxide concentration by MSA, 1985.

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 1

METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE HIGHEST 1983	CONCENTRATION 2ND MAX 24-HR AVG. 1984	(PPM) 1985
POPULATION: > 2 MILLION			
NEW YORK, NY	.093	.084	.063
LOS ANGELES-LONG BEACH, CA	.037	.035	.029
CHICAGO, IL	.048	.089	.105
PHILADELPHIA, PA-NJ	.056	.076	.067
DETROIT, MI	.061	.063	.056
WASHINGTON, DC-MD-VA	.065	.045	.042
HOUSTON, TX	.040 *	.065	.039
BOSTON, MA	.054	.073	.049
NASSAU-SUFFOLK, NY	.044	.075	.047
ST. LOUIS, MO-IL	.123	.136	.103
ATLANTA, GA	.052	.028	.038
MINNEAPOLIS-ST. PAUL, MN-WI	.089	.087	.101
BALTIMORE, MD	.060	.050	.035

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 2

METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1983	1984	1985
POPULATION: > 2 MILLION (CONT)			
DALLAS, TX	.017	.018	.016
PITTSBURGH, PA	.197 **	.210 **	.168 **
ANAHEIM-SANTA ANA, CA	.015	.016	.016
SAN DIEGO, CA	.018	.021	.021

TOTAL MSA'S > 2 MILLION : 17

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
** = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.
THE NEXT HIGHEST SITE RECORDED A 2ND MAX 24-AVG OF 0.124 PPM IN 1985.
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 3

METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1983	1984	1985
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.052	.061	.047
OAKLAND, CA	.025	.021	.014
CLEVELAND, OH	.091 *	.106	.079
RIVERSIDE-SAN BERNARDINO, CA	.012	.010	.008
TAMPA-ST. PETERSBURG-CLEARWATER, FL	.043	.036	.041
PHOENIX, AZ	.012	.013 *	.017 *
MIAMI-HIALEAH, FL	.008	.006 *	.004 *
SEATTLE, WA	.047	.045	.028
DENVER, CO	.041	.035	.023
SAN FRANCISCO, CA	.014	.033	.026
SAN JUAN, PR	ND	ND	ND
KANSAS CITY, MO-KS	.042	.042	.039
CINCINNATI, OH-KY-IN	.090	.078	.087

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 4

METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1983	 1984	 1985
POPULATION: 1 - 2 MILLION (CONT)			
MILWAUKEE, WI	.056	.060	.046
SAN JOSE, CA	ND	ND	ND
NEW ORLEANS, LA	.026	.027	.036
BERGEN-PASSAIC, NJ	.044	.063	.049
COLUMBUS, OH	.068	.083	.059
NORFOLK-VIRGINIA BEACH-NEWPORT NEWS, VA	.036	.031	.037
SACRAMENTO, CA	.008	.010	.009
INDIANAPOLIS, IN	.102	.077	.129
SAN ANTONIO, TX	.011	.010	.010
FORT WORTH-ARLINGTON, TX	.048	.047	.031
PORTLAND, OR-WA	.025	.027	.025 *
FORT LAUDERDALE-HOLLYWOOD-POMPANO BEACH, FL	.011 *	ND	ND
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	.026	.035	.032

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 5

METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG.		
	1983	1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
SALT LAKE CITY-OGDEN, UT	.090	.080	.070
TOTAL MSA'S 1 - 2 MILLION : 27			

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 6

METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1983	1984	1985
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.050	.052	.050
BUFFALO, NY	.100	.075	.076
OKLAHOMA CITY, OK	.020 *	.024 *	.018
LOUISVILLE, KY-IN	.079	.082	.062
MEMPHIS, TN-AR-MS	.045	.067	.079 *
DAYTON-SPRINGFIELD, OH	.036	.044	.049
MIDDLESEX-SOMERSET-HUNTERDON, NJ	.058	.075	.048
MONMOUTH-OCEAN, NJ	.036	ND	ND
BIRMINGHAM, AL	.069 *	ND	.023
NASHVILLE, TN	.056	.088	.074
GREENSBORO-WINSTON SALEM-HIGH POINT, NC	.018	.025	.024
ALBANY-SCHENECTADY-TROY, NY	.056	.060	.035
ORLANDO, FL	.021	.014	.012

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY MSA POPULATTON RANGE PAGE NO: 7

METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE HIGHEST 1983	CONCENTRATION 2ND MAX 24-HR AVG. 1984	(PPM) 1985
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	.023 *	.025	.034
RICHMOND-PETERSBURG, VA	.032	.041	.026
JACKSONVILLE, FL	.064	.052	.068
HARTFORD, CT	.054	.081	.039
SCRANTON-WILKES-BARRE, PA	.045	.065	.047
TULSA, OK	.044	.057	.080
WEST PALM BEACH-BOCA RATON-DELRAY BEACH, FL	.009	.014	.009
SYRACUSE, NY	.056	.121 **	.285 **
AKRON, OH	.054	.062	.081
ALLENTOWN-BETHLEHEM, PA-NJ	.046	.064	.046 *
AUSTIN, TX	.011	.010	.019
GARY-HAMMOND, IN	.090 *	.106	.131
GRAND RAPIDS, MI	.034	.026	.063 *

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
** = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.
THE NEXT HIGHEST SITE RECORDED A 2ND MAX 24-AVG OF 0.029 PPM IN 1985.
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 8

METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
PROVIDENCE, RI	.047	.068	.047
TOLEDO, OH	.068	.038	.099
RALEIGH-DURHAM, NC	ND	ND	ND
OMAHA, NE-IA	.018 *	.012	.006 *
TUCSON, AZ	.016	.082	.079 *
GREENVILLE-SPARTANBURG, SC	.025	.013 *	.018
KNOXVILLE, TN	.050	.034	.058
OXNARD-VENTURA, CA	.010	.010	.008
HARRISBURG-LEBANON-CARLISLE, PA	.032	.047	.033
FRESNO, CA	.016	.016	.012
JERSEY CITY, NJ	.048	.058	.051
WILMINGTON, DE-NJ-MD	.058	.062	.053
BATON ROUGE, LA	.035	.042	.073

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 SULFUR DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 9

METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
LAS VEGAS, NV	ND	ND	ND
EL PASO, TX	.118	.097	.085
YOUNGSTOWN-WARREN, OH	.048	.052	.050
TACOMA, WA	.065	.035	.034
SPRINGFIELD, MA	.063	.068	.054
NEW HAVEN-MERIDEN, CT	.057	.080	.069

TOTAL MSA'S .5 - 1 MILLION : 45

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

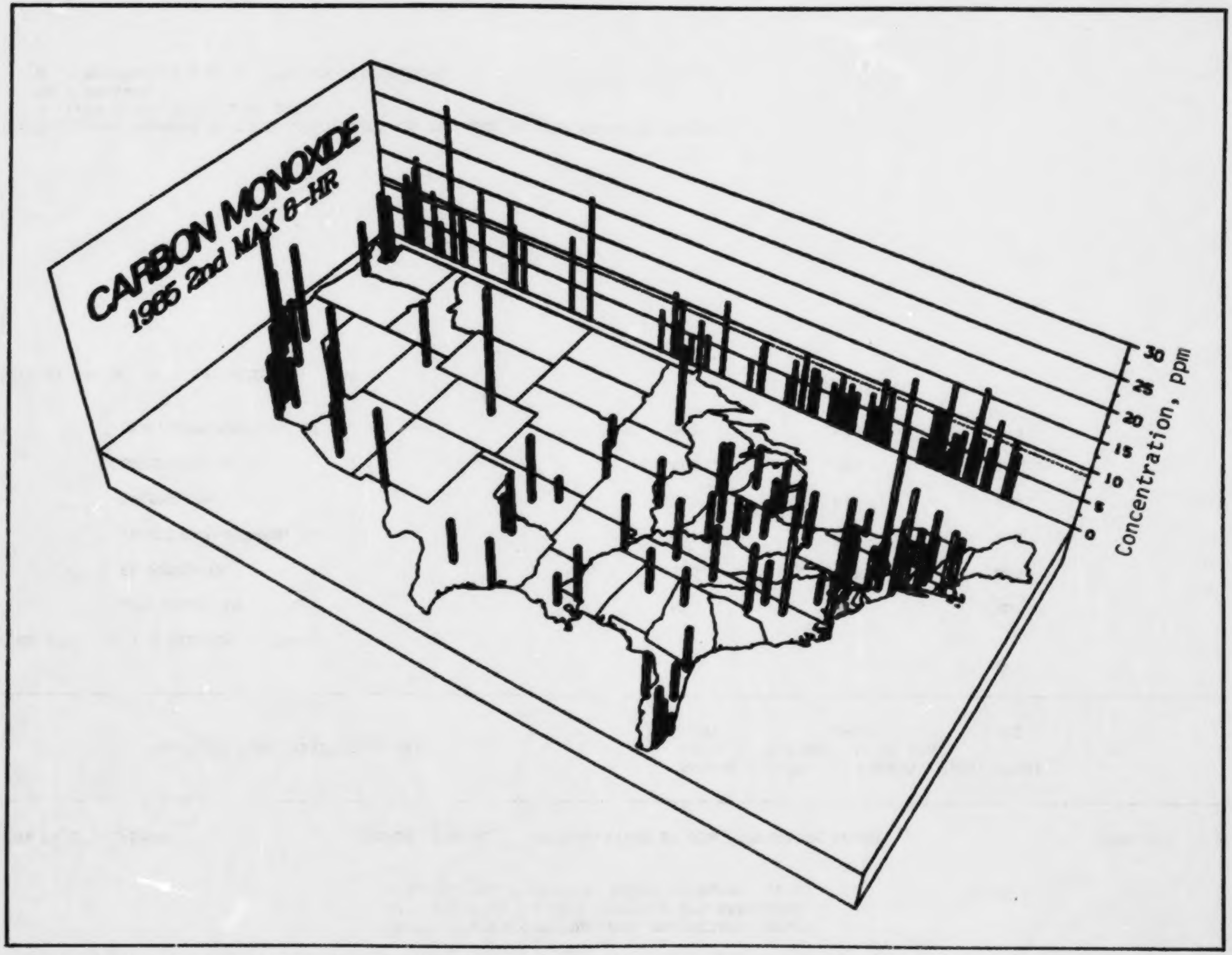

Figure 4-5. United States map of the highest second maximum non-overlapping 8-hour average carbon monoxide concentration by MSA, 1985.

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 CARBON MONOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 1

METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1983	1984	1985
POPULATION: > 2 MILLION			
NEW YORK, NY	13	15	16
LOS ANGELES-LONG BEACH, CA	19	19	27
CHICAGO, IL	13	11	8
PHILADELPHIA, PA-NJ	11	10	8
DETROIT, MI	9	11	8
WASHINGTON, DC-MD-VA	13	14	10
HOUSTON, TX	9 *	7	8
BOSTON, MA	14	10	8
NASSAU-SUFFOLK, NY	10	10	8
ST. LOUIS, MO-IL	19	7	8
ATLANTA, GA	9	11	9
MINNEAPOLIS-ST. PAUL, MN-WI	15	13	13
BALTIMORE, MD	13	14	10

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 CARBON MONOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 2

METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1983	1984	1985
POPULATION: > 2 MILLION (CONT)			
DALLAS, TX	7	7	10
PITTSBURGH, PA	13	10	9
ANAHEIM-SANTA ANA, CA	11	10	13
SAN DIEGO, CA	9	8	10

TOTAL MSA'S > 2 MILLION : 17

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 CARBON MONOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 3

METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1983	1984	1985
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	11	18	11
OAKLAND, CA	5	7	6
CLEVELAND, OH	10	7	8
RIVERSIDE-SAN BERNARDINO, CA	9	7	8
TAMPA-ST. PETERSBURG-CLEARWATER, FL	7	7	7
PHOENIX, AZ	20	17	15
MIAMI-HIALEAH, FL	11	10 *	10
SEATTLE, WA	11	10	11
DENVER, CO	24	20	21
SAN FRANCISCO, CA	9	8	12
SAN JUAN, PR	8	7	7
KANSAS CITY, MO-KS	7	13	6
CINCINNATI, OH-KY-IN	7	7	7

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 CARBON MONOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 4

METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1983	1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
MILWAUKEE, WI	7	12	5
SAN JOSE, CA	10	10	14
NEW ORLEANS, LA	8	9	9
BERGEN-PASSAIC, NJ	12	11	7
COLUMBUS, OH	9	8	6
NORFOLK-VIRGINIA BEACH-NEWPORT NEWS, VA	11	11	8
SACRAMENTO, CA	16	14	16
INDIANAPOLIS, IN	13	9	8
SAN ANTONIO, TX	9	8	7
FORT WORTH-ARLINGTON, TX	5	6	6
PORTLAND, OR-WA	12	10	9
FORT LAUDERDALE-HOLLYWOOD-POMPANO BEACH, FL	9	8	7
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	13	11	11

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 CARBON MONOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 5

METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1983	 1984	 1985
POPULATION: 1 - 2 MILLION (CONT)			
SALT LAKE CITY-OGDEN, UT	12 *	11	11
TOTAL MSA'S 1 - 2 MILLION : 27			

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 CARBON MONOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 6

METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1983	1984	1985
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	5	5	4
BUFFALO, NY	5	5	5
OKLAHOMA CITY, OK	9	13	11
LOUISVILLE, KY-IN	10	12	8
MEMPHIS, TN-AR-MS	11	10 *	9
DAYTON-SPRINGFIELD, OH	7	7	5
MIDDLESEX-SOMERSET-HUNTERDON, NJ	7	8	7
MONMOUTH-OCEAN, NJ	9	8	8
BIRMINGHAM, AL	10	10	7
NASHVILLE, TN	11	10 *	10
GREENSBORO-WINSTON SALEM-HIGH POINT, NC	8	11	7
ALBANY-SCHENECTADY-TROY, NY	6	7	6
ORLANDO, FL	7	7	6 *

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 CARBON MONOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 7

METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	6	6	6
RICHMOND-PETERSBURG, VA	8 *	7	4
JACKSONVILLE, FL	10	8	7
HARTFORD, CT	10	12	12
SCRANTON-WILKES-BARRE, PA	6	7	4
TULSA, OK	7	7	4
WEST PALM BEACH-BOCA RATON-DELRAY BEACH, FL	7	4	3
SYRACUSE, NY	10 *	12	15
AKRON, OH	8	5	5
ALLENTOWN-BETHLEHEM, PA-NJ	8	8	7
AUSTIN, TX	ND	ND	ND
GARY-HAMMOND, IN	7	6	6
GRAND RAPIDS, MI	5	5 *	7

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 CARBON MONOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 8

METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1983	 1984	 1985
POPULATION: .5 - 1 MILLION (CONT)			
PROVIDENCE, RI	11	11	10
TOLEDO, OH	7	11	6
RALEIGH-DURHAM, NC	13	17	13
OMAHA, NE-IA	8	8	5 *
TUCSON, AZ	11	10	9
GREENVILLE-SPARTANBURG, SC	ND	ND	ND
KNOXVILLE, TN	7	9	9
OXNARD-VENTURA, CA	6	5	6
HARRISBURG-LEBANON-CARLISLE, PA	12	7	6 *
FRESNO, CA	12	11	11
JERSEY CITY, NJ	12	14	11
WILMINGTON, DE-NJ-MD	7	8	7
BATON ROUGE, LA	5	3	5

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 CARBON MONOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 9

METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
LAS VEGAS, NV	15	16 *	15
EL PASO, TX	11	13 *	13
YOUNGSTOWN-WARREN, OH	5	5	5
TACOMA, WA	10	10	12
SPRINGFIELD, MA	11	10	7
NEW HAVEN-MERIDEN, CT	8	6 *	7

TOTAL MSA'S .5 - 1 MILLION : 45

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

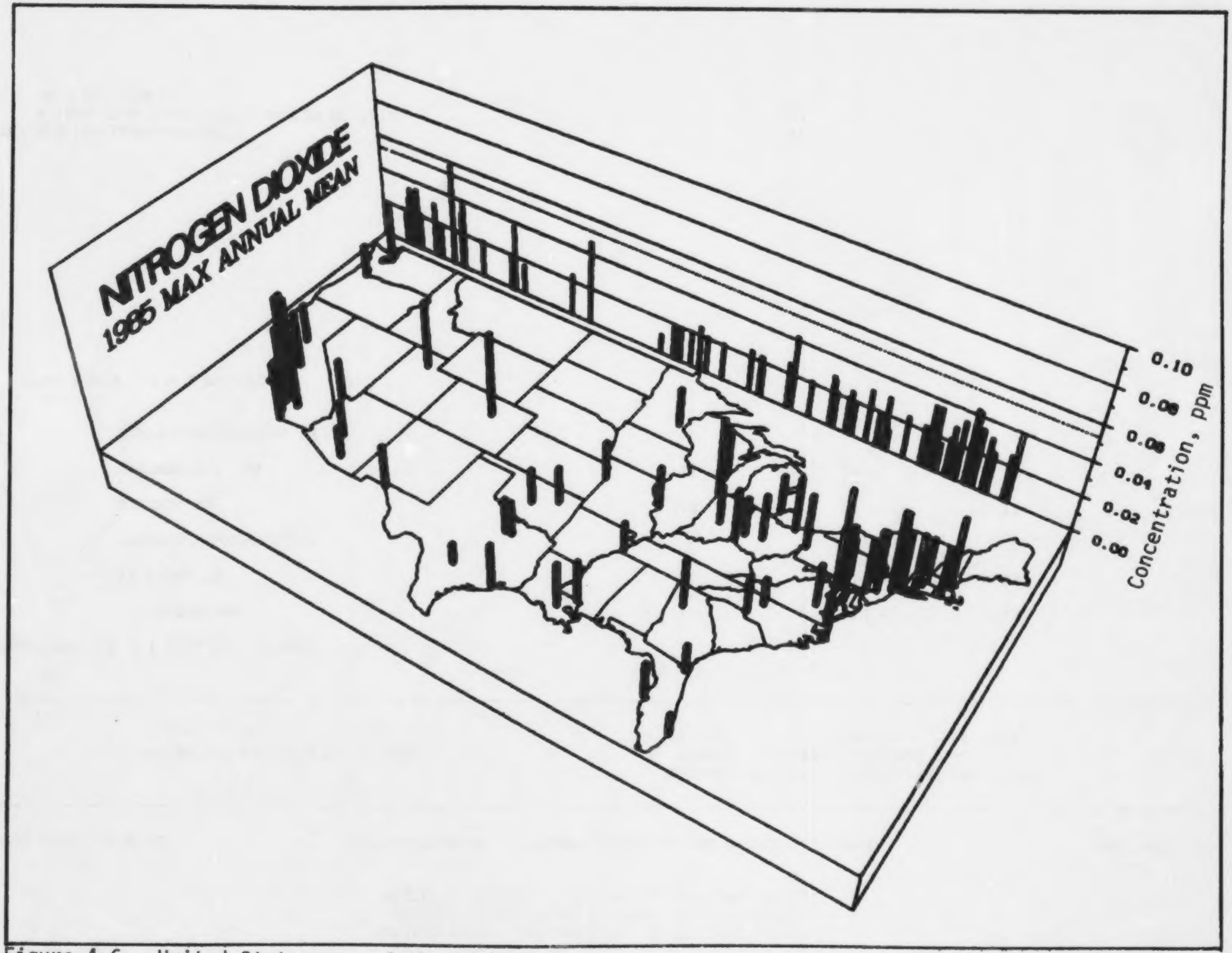

Figure 4-6. United States map of the highest annual arithmetic mean nitrogen dioxide concentration by MSA, 1985.

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 NITROGEN DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 1

METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: > 2 MILLION			
NEW YORK, NY	.037	.041	.042
LOS ANGELES-LONG BEACH, CA	.059	.057	.058
CHICAGO, IL	.044 B	.044 B	.042
PHILADELPHIA, PA-NJ	.041	.040	.034
DETROIT, MI	.026	.025	.021
WASHINGTON, DC-MD-VA	.037 B	.032	.036
HOUSTON, TX	.027	.029	.025
BOSTON, MA	.026	.044	.040
NASSAU-SUFFOLK, NY	.034	.035	.033
ST. LOUIS, MO-IL	.026	.033	.034
ATLANTA, GA	.025	.026	.027
MINNEAPOLIS-ST. PAUL, MN-WI	.017	.019	.021
BALTIMORE, MD	.033	.034	.036

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 NITROGEN DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 2

METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	 1984	 1985
POPULATION: > 2 MILLION (CONT)			
DALLAS, TX	.017	.016	.019
PITTSBURGH, PA	.035	.031	.030
ANAHEIM-SANTA ANA, CA	.045	.046	.043
SAN DIEGO, CA	.027	.031	.032

TOTAL MSA'S > 2 MILLION : 17

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 NITROGEN DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 3

METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.043	.042	.043
OAKLAND, CA	.023	.025	.026
CLEVELAND, OH	.028	.029	.030
RIVERSIDE-SAN BERNARDINO, CA	.042	.040	.040
TAMPA-ST. PETERSBURG-CLEARWATER, FL	.015	.021	.019
PHOENIX, AZ	.018	.025	.020
MIAMI-HIALEAH, FL	.023	.009	IN
SEATTLE, WA	.031	.033	.034
DENVER, CO	.052	.047	.048
SAN FRANCISCO, CA	.026	.029	.028
SAN JUAN, PR	ND	ND	ND
KANSAS CITY, MO-KS	.017	.018	.021
CINCINNATI, OH-KY-IN	.036	.030	.029

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 NITROGEN DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 4

METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
MILWAUKEE, WI	.026	.028	.026
SAN JOSE, CA	.030	.032	.035
NEW ORLEANS, LA	.034 B	.026	.023 B
BERGEN-PASSAIC, NJ	.036	.037	.034
COLUMBUS, OH	.023	.024	.025
NORFOLK-VIRGINIA BEACH-NEWPORT NEWS, VA	.016	.016	.017
SACRAMENTO, CA	.017	.019	.021
INDIANAPOLIS, IN	.028	.024	.021
SAN ANTONIO, TX	.015	.013	.011
FORT WORTH-ARLINGTON, TX	.018	.016	.019
PORTLAND, OR-WA	ND	IN	.018
FORT LAUDERDALE-HOLLYWOOD-POMPANO BEACH, FL	IN	ND	ND
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	.024 B	.015	.020

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 NITROGEN DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 5

METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
SALT LAKE CITY-OGDEN, UT	.029	.037	.038
TOTAL MSA'S 1 - 2 MILLION : 27			

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 NITROGEN DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 6

METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	ND	ND	ND
BUFFALO, NY	.025	.024	.024
OKLAHOMA CITY, OK	.016	.020	.019
LOUISVILLE, KY-IN	.021	.016	IN
MEMPHIS, TN-AR-MS	.003	IN	.016
DAYTON-SPRINGFIELD, OH	.027	.023	.021
MIDDLESEX-SOMERSET-HUNTERDON, NJ	.029	.025	.023
MONMOUTH-OCEAN, NJ	ND	ND	ND
BIRMINGHAM, AL	ND	ND	ND
NASHVILLE, TN	ND	ND	ND
GREENSBORO-WINSTON SALEM-HIGH POINT, NC	.028 B	.014	.015
ALBANY-SCHENECTADY-TROY, NY	ND	ND	ND
ORLANDO, FL	.011	.010	IN

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 NITROGEN DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 7

METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	ND	ND	ND
RICHMOND-PETERSBURG, VA	.024	.024	.023
JACKSONVILLE, FL	IN	IN	.015
HARTFORD, CT	.021	.021	.021
SCRANTON-WILKES-BARRE, PA	.018	.020	.022
TULSA, OK	.022	.018	.020
WEST PALM BEACH-BOCA RATON-DELRAY BEACH, FL	.010	.015	.012
SYRACUSE, NY	ND	ND	ND
AKRON, OH	ND	ND	ND
ALLENTOWN-BETHLEHEM, PA-NJ	.022	.024	.019
AUSTIN, TX	ND	ND	ND
GARY-HAMMOND, IN	.010	.010	IN
GRAND RAPIDS, MI	ND	ND	ND

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 NITROGEN DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 8

METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
PROVIDENCE, RI	.024	.025	.026
TOLEDO, OH	ND	ND	ND
RALEIGH-DURHAM, NC	ND	ND	ND
OMAHA, NE-IA	ND	ND	ND
TUCSON, AZ	.020	.026	.017
GREENVILLE-SPARTANBURG, SC	ND	ND	ND
KNOXVILLE, TN	ND	ND	ND
OXNARD-VENTURA, CA	.025	.026	.018
HARRISBURG-LEBANON-CARLISLE, PA	.020	.021	.021
FRESNO, CA	.025	.027	.031
JERSEY CITY, NJ	.032	.028	.032
WILMINGTON, DE-NJ-MD	.032	.032	.029
BATON ROUGE, LA	.031 B	.029 B	.024

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 NITROGEN DIOXIDE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 9

METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
LAS VEGAS, NV	.024	.029	.021
EL PASO, TX	.019	.021	.024
YOUNGSTOWN-WARREN, OH	.025	.028	ND
TACOMA, WA	ND	ND	ND
SPRINGFIELD, MA	.025	.025	.024
NEW HAVEN-MERIDEN, CT	.030	.031	.031

TOTAL MSA'S .5 - 1 MILLION : 45

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4360 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

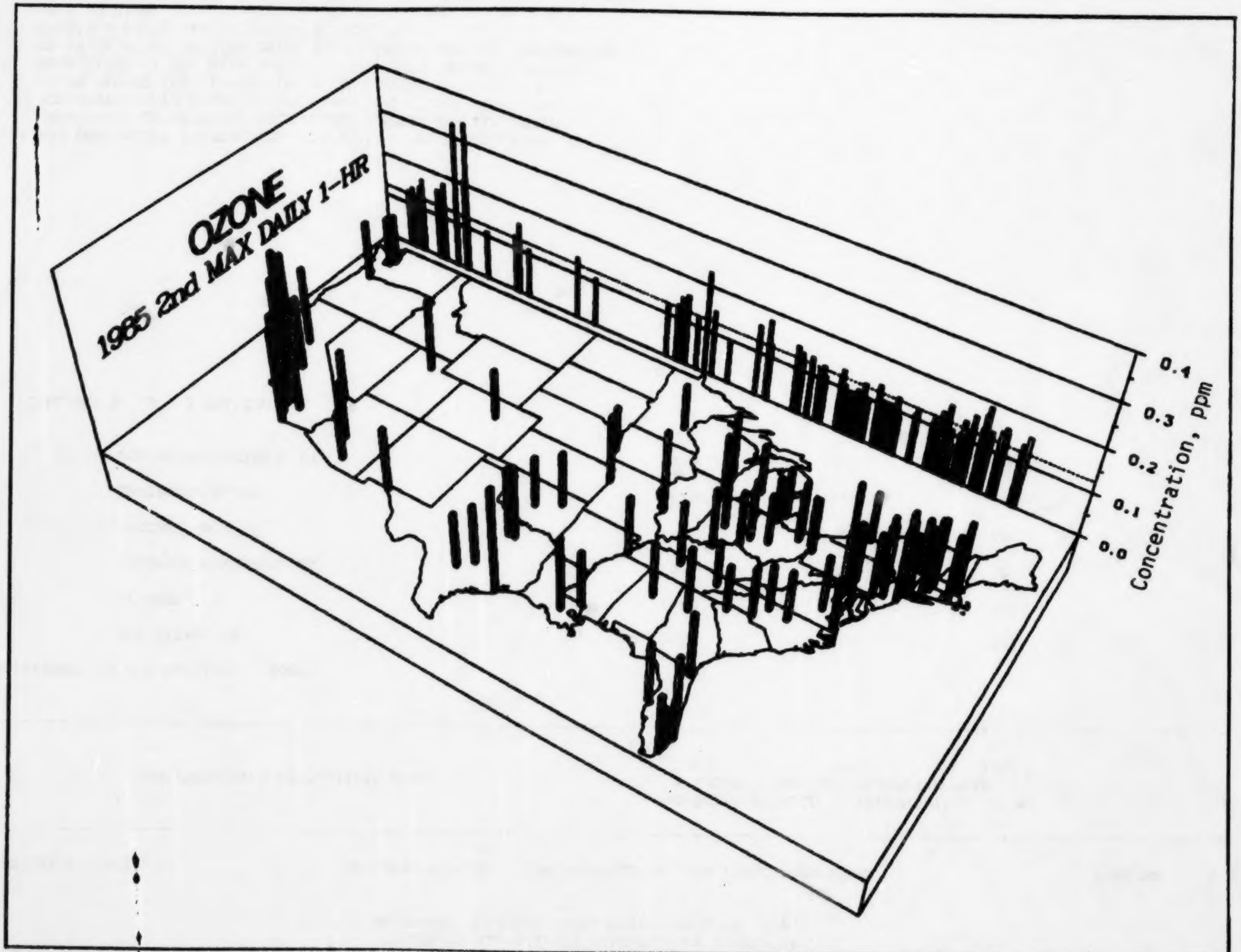

OZONE
1985 2nd MAX DAILY 1-HR
0.4
0.3
0.2
0.1
0.0
Concentration, ppm

Figure 4-7. United States map of the highest second daily maximum 1-hour average ozone concentration by MSA, 1985.

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 OZONE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 1

METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1983	1984	1985
POPULATION: > 2 MILLION			
NEW YORK, NY	.19	.17	.16
LOS ANGELES-LONG BEACH, CA	.37	.29	.33
CHICAGO, IL	.17	.15	.14
PHILADELPHIA, PA-NJ	.19	.20	.16
DETROIT, MI	.14	.12	.11
WASHINGTON, DC-MD-VA	.17	.14	.14 *
HOUSTON, TX	.28	.21	.23
BOSTON, MA	.18	.15	.16
NASSAU-SUFFOLK, NY	.17	.10	.14
ST. LOUIS, MO-IL	.18	.17	.18
ATLANTA, GA	.17	.15	.14
MINNEAPOLIS-ST. PAUL, MN-WI	.13	.12	.10
BALTIMORE, MD	.17	.15	.16

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 OZONE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 2

METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1983	1-HR CONCENTRATION 2ND HIGH 1984	DAILY MAX (PPM) 1985
POPULATION: > 2 MILLION (CONT)			
DALLAS, TX	.16	.16	.16 *
PITTSBURGH, PA	.14	.11	.12
ANAHEIM-SANTA ANA, CA	.28	.26	.28
SAN DIEGO, CA	.20	.20	.21

TOTAL MSA'S > 2 MILLION : 17

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNINS AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 OZONE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 3

METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1983	1-HR CONCENTRATION (PPM) 2ND HIGH DAILY MAX 1984	1985
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.19	.12	.14
OAKLAND, CA	.17	.15	.14
CLEVELAND, OH	.15	.14	.12
RIVERSIDE-SAN BERNARDINO, CA	.34	.32	.34
TAMPA-ST. PETERSBURG-CLEARWATER, FL	.14	.13	.13
PHOENIX, AZ	.16	.15	.13
MIAMI-HIALEAH, FL	.12	.10	.13
SEATTLE, WA	.10	.09	.11
DENVER, CO	.14	.12	.11
SAN FRANCISCO, CA	.14	.11	.11
SAN JUAN, PR	.03	.08	ND
KANSAS CITY, MO-KS	.13	.14	.15
CINCINNATI, OH-KY-IN	.15	.12	.12

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 OZONE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 4

METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1983	CONCENTRATION (PPM) 1-HR 2ND HIGH DAILY MAX 1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
MILWAUKEE, WI	.18	.16	.15
SAN JOSE, CA	.16	.16	.15
NEW ORLEANS, LA	.12	.12	.12
BERGEN-PASSAIC, NJ	.17	.16	.14
COLUMBUS, OH	.12	.11	.11
NORFOLK-VIRGINIA BEACH-NEWPORT NEWS, VA	.13	.12	.11
SACRAMENTO, CA	.15	.19	.17
INDIANAPOLIS, IN	.14	.12	.12
SAN ANTONIO, TX	.12	.12	.12
FORT WORTH-ARLINGTON, TX	.14 *	.16	.15
PORTLAND, OR-WA	.12	.13	.13
FORT LAUDERDALE-HOLLYWOOD-POMPANO BEACH, FL	.11	.10	.09
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	.15	.13	.11

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 OZONE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 5

METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1983	1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
SALT LAKE CITY-OGDEN, UT	.14	.15	.16
TOTAL MSA'S 1 - 2 MILLION : 27			

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 OZONE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 6

METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1983	CONCENTRATION (PPM) 1-HR 2ND HIGH DAILY MAX 1984	1985
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.12	.11	.11
BUFFALO, NY	.12	.11	.12
OKLAHOMA CITY, OK	.11	.12	.11
LOUISVILLE, KY-IN	.16	.15	.13
MEMPHIS, TN-AR-MS	.15	.13	.13
DAYTON-SPRINGFIELD, OH	.13	.12	.11
MIDDLESEX-SOMERSET-HUNTERDON, NJ	.25	.19	.19
MONMOUTH-OCEAN, NJ	ND	ND	.15
BIRMINGHAM, AL	.15	.11	.12
NASHVILLE, TN	.12	.13	.14
GREENSBORO-WINSTON SALEM-HIGH POINT, NC	.12	.11	.10
ALBANY-SCHENECTADY-TROY, NY	.12	.09	.12
ORLANDO, FL	.11	.11	.11

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 OZONE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 7

METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1983	1984	1985	
POPULATION: .5 - 1 MILLION (CONT)				
HONOLULU, HI	.06	.07	.06	
RICHMOND-PETERSBURG, VA	.14	.13	.12	
JACKSONVILLE, FL	.14	.11	.14	
HARTFORD, CT	.19	.17	.16	
SCRANTON-WILKES-BARRE, PA	.13	.11	.11	
TULSA, OK	.13	.13	.12	
WEST PALM BEACH-BOCA RATON-DELRAY BEACH, FL	.12	.09	.09	
SYRACUSE, NY	.08	ND	.08	
AKRON, OH	.13	.11	.11	
ALLENTOWN-BETHLEHEM, PA-NJ	.14	.13	.12	
AUSTIN, TX	.12	.11	.13	
GARY-HAMMOND, IN	.17	.15	.12	*
GRAND RAPIDS, MI	.13	.11	.11	

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 OZONE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 8

METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
PROVIDENCE, RI	.15	.20	.14
TOLEDO, OH	.13	.11	.10
RALEIGH-DURHAM, NC	.13	.10	.11
OMAHA, NE-IA	.09	.10	.10
TUCSON, AZ	.11	.11	.11
GREENVILLE-SPARTANBURG, SC	.11	.08 *	.10
KNOXVILLE, TN	.11	.10 *	.10
OXNARD-VENTURA, CA	.21	.17	.18
HARRISBURG-LEBANON-CARLISLE, PA	.16	.12	.11
FRESNO, CA	.16	.15	.16
JERSEY CITY, NJ	.16	.13	.17
WILMINGTON, DE-NJ-MD	.18	.14	.14
BATON ROUGE, LA	.14	.16	.16

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 10/22/86 OZONE CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 9

METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
LAS VEGAS, NV	.11 *	.12	.11
EL PASO, TX	.14	.16 *	.14
YOUNGSTOWN-WARREN, OH	.11	.09	.11
TACOMA, WA	.10	.09	.11
SPRINGFIELD, MA	.19	.17	.15
NEW HAVEN-MERIDEN, CT	.22	.20	.15

TOTAL MSA'S .5 - 1 MILLION : 45

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

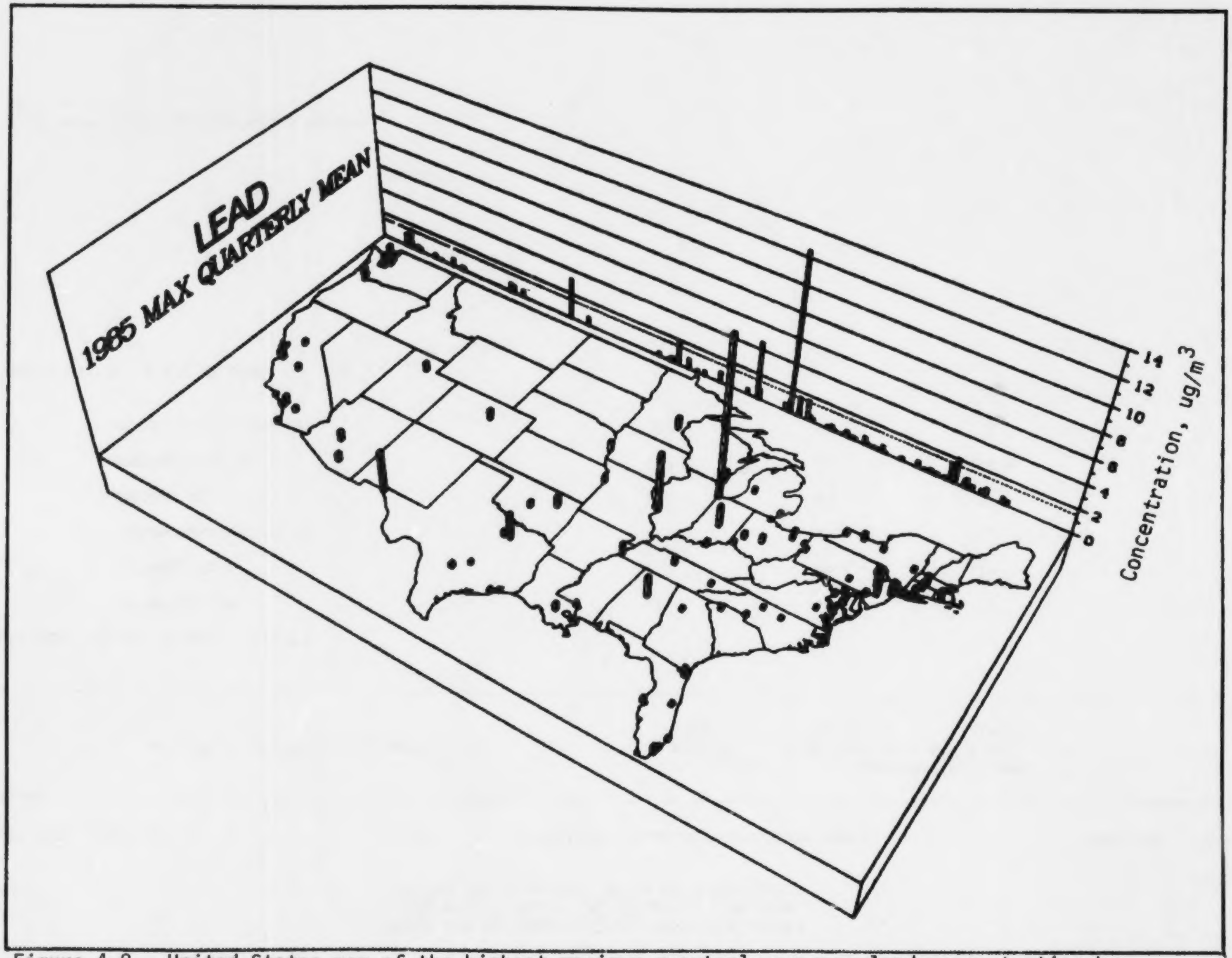

LEAD
1985 MAX QUARTERLY MEAN
Concentration, ug/m3
14
12
10
8
6
4
2
0

Figure 4-8. United States map of the highest maximum quarterly average lead concentration by MSA, 1985.

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 09/09/86 LEAD CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 1

METROPOLITAN STATISTICAL AREA	LEAD HIGHEST 1983	CONCENTRATION (UG/M3) MAXIMUM QUARTERLY AVERAGE 1984	1985
POPULATION: > 2 MILLION			
NEW YORK, NY	.90	.91	.60
LOS ANGELES-LONG BEACH, CA	1.04	1.03	.63
CHICAGO, IL	.79 M	.68	1.05
PHILADELPHIA, PA-NJ	3.66 *	5.13 *	2.07 *
DETROIT, MI	.82 Q	.69 Q	.27 M
WASHINGTON, DC-MD-VA	.60	.49	.21
HOUSTON, TX	.44	.39	.26
BOSTON, MA	.56	.48	.43
NASSAU-SUFFOLK, NY	.60	.67	.45
ST. LOUIS, MO-IL	6.70 *	2.41 *	4.61 *
ATLANTA, GA	.70 M	.47 M	.19 M
MINNEAPOLIS-ST. PAUL, MN-WI	.71	1.01	.89
BALTIMORE, MD	.60	.60	.37

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.
THE 2ND HIGHEST MAX QUARTERLY AVERAGE IN 1985 WAS 1.26 UG/M3 FOR PHILADELPHIA
AND 0.59 UG/M3 FOR ST. LOUIS.
ND = NO DATA

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 09/09/86 LEAD CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 2

METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1983	1984	1985
POPULATION: > 2 MILLION (CONT)			
DALLAS, TX	1.33	1.52	2.01
PITTSBURGH, PA	.36	.33	.24
ANAHEIM-SANTA ANA, CA	.59	.61	.34
SAN DIEGO, CA	.55	.53	.33

TOTAL MSA'S > 2 MILLION : 17

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 09/09/86 LEAD CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 3

METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE		
	1983	1984	1985
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.55	.56	.51
OAKLAND, CA	.31	.29	.16
CLEVELAND, OH	.40	.38 M	.34 M
RIVERSIDE-SAN BERNARDINO, CA	.55	.55	.31
TAMPA-ST. PETERSBURG-CLEARWATER, FL	1.01	.57	.26
PHOENIX, AZ	1.08	1.29	.72
MIAMI-HIALEAH, FL	1.39	.93	.58
SEATTLE, WA	7.57 M*	1.56 M*	1.55 M*
DENVER, CO	1.04	.90 M	.70 M
SAN FRANCISCO, CA	.36	.43	.26
SAN JUAN, PR	1.30	1.30	1.26
KANSAS CITY, MO-KS	.33	.34	.41
CINCINNATI, OH-KY-IN	.48	.50 M	.25 M

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.
ND = NO DATA

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 09/09/86 LEAD CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 4

METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1983	1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
MILWAUKEE, WI	.48	.72	.61
SAN JOSE, CA	.54	.51	.42
NEW ORLEANS, LA	.23	.56	.22
BERGEN-PASSAIC, NJ	.87	.92	.62
COLUMBUS, OH	.57 M	.62 M	.52 M
NORFOLK-VIRGINIA BEACH-NEWPORT NEWS, VA	.39	.33	.14
SACRAMENTO, CA	.68	.47	.33
INDIANAPOLIS, IN	.63	1.14	1.64
SAN ANTONIO, TX	.64	.67	.35
FORT WORTH-ARLINGTON, TX	1.00	.57	.40
PORTLAND, OR-WA	1.37	1.58	1.00 M
FORT LAUDERDALE-HOLLYWOOD-POMPANO BEACH, FL	.71	.23	.18
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	.43	.44	.22

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 09/09/86 LEAD CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 5

METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1983	1984	1985
POPULATION: 1 - 2 MILLION (CONT)			
SALT LAKE CITY-OGDEN, UT	.74	.70	.60
TOTAL MSA'S 1 - 2 MILLION : 27			

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 09/09/86 LEAD CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 6

METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1983	1984	1985
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.51	.67	.55
BUFFALO, NY	.69	.51	.32
OKLAHOMA CITY, OK	.51	.59	.37
LOUISVILLE, KY-IN	.73 M	.60 M	.45 M
MEMPHIS, TN-AR-MS	1.17	1.41	.88
DAYTON-SPRINGFIELD, OH	.67	.52 M	.45 M
MIDDLESEX-SOMERSET-HUNTERDON, NJ	2.12 *	1.73 *	.81 *
MONMOUTH-OCEAN, NJ	ND	ND	ND
BIRMINGHAM, AL	4.17 *	5.33 *	1.59 *
NASHVILLE, TN	.58	.36	.54
GREENSBORO-WINSTON SALEM-HIGH POINT, NC	.43	.50	.18
ALBANY-SCHENECTADY-TROY, NY	.30	.48	.22
ORLANDO, FL	.31	.39	.18

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.
ND = NO DATA

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 09/09/86 LEAD CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 7

METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	.23	1.00	.26
RICHMOND-PETERSBURG, VA	.36	.46	.16
JACKSONVILLE, FL	1.15	1.26	.66
HARTFORD, CT	.45	.57	.57 M
SCRANTON-WILKES-BARRE, PA	.37	.46	.22
TULSA, OK	.69	.75	.83
WEST PALM BEACH-BOCA RATON-DELRAY BEACH, FL	.25	.33	.18
SYRACUSE, NY	.34	.46	.27
AKRON, OH	.22	.46 M	.32 M
ALLENTOWN-BETHLEHEM, PA-NJ	.76	1.13	1.52
AUSTIN, TX	.53	ND	.18
GARY-HAMMOND, IN	.66	2.95 *	12.50 *
GRAND RAPIDS, MI	.78	.66	.35

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.
ND = NO DATA

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 09/09/86 LEAD CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 8

METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
PROVIDENCE, RI	.93	.58	.53
TOLEDO, OH	.18	.19	.11
RALEIGH-DURHAM, NC	.42	.54	.18
OMAHA, NE-IA	1.23	.91	.75
TUCSON, AZ	.65	.59	.58
GREENVILLE-SPARTANBURG, SC	.24	.64	.31
KNOXVILLE, TN	.35	.43	.18
OXNARD-VENTURA, CA	.37	.29	.17
HARRISBURG-LEBANON-CARLISLE, PA	.25	.34	.13
FRESNO, CA	.70	.60	.37
JERSEY CITY, NJ	.51	.94	.37
WILMINGTON, DE-NJ-MD	1.81 *	.63	.30
BATON ROUGE, LA	.56	.58	.50

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.
ND = NO DATA

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

REPORT DATE 09/09/86 LEAD CONCENTRATION BY MSA POPULATION RANGE PAGE NO: 9

METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1983	1984	1985
POPULATION: .5 - 1 MILLION (CONT)			
LAS VEGAS, NV	.73	.55	ND
EL PASO, TX	1.67	1.60	3.25
YOUNGSTOWN-WARREN, OH	.29	.31	.15
TACOMA, WA	.54 M	.47	.97
SPRINGFIELD, MA	1.00	1.09	.72
NEW HAVEN-MERIDEN, CT	.60 M	.55 M	.45 M

TOTAL MSA'S .5 - 1 MILLION : 45

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA

5. TRENDS ANALYSES FOR 14 URBANIZED AREAS

This chapter presents trends in ambient air quality for the period 1981 - 1985 in 14 urbanized areas. The urbanized areas included in these analyses are Atlanta, GA; Baltimore, MD; Boston, MA; Chicago, IL-Northwestern IN; Denver, CO; Detroit, MI; Houston, TX; Los Angeles-Long Beach, CA; New York, NY-Northeastern NJ; Philadelphia, PA-NJ; Phoenix, AZ; Portland, OR-WA; Seattle, WA; and St. Louis, MO-IL. These cities were selected because they were among the largest cities in each of the EPA Regions. Where sufficient data were available, trends are presented for the criteria pollutants TSP, SO_2, CO, NO_2, O_3, and Pb. The urbanized areas were grouped into five broad geographic areas: East, Midwest, South, Southwest, and Northwest. Composite averages were then calculated for each pollutant and compared to the national averages.

The air quality data used for the trend statistics in this section were obtained from the EPA National Aerometric Data Bank (NADB). Additionally, limited data were taken from State annual reports. The monitoring sites used for the trends analyses were required to satisfy the historical continuity criteria of 4 out of 5 years of data in the period 1981 to 1985 except for lead which required 1 valid quarter per year. Furthermore, each year with data generally had to meet the annual data completeness criteria as described in Section 2.1.

The urbanized area air quality trends focus on the period 1981 through 1985 which complements the 5-year national trends analyses in Section 3. The national trends analyses also include a 10-year trend (1976 to 1985). Although some of the 14 urbanized areas had sufficient data to prepare area trends for the 10-year period (1976 to 1985), several of the urbanized areas did not have sufficient data to meet the 8 of 10-year data completeness criteria. Therefore, only the 5-year trend is presented.

The air quality trends in this chapter are based on monitoring sites located within the boundaries of the urbanized areas (except for O_3) as described in the 1980 Census of Population Report prepared by the U.S. Bureau of Census.[1] The report defines an urbanized area as consisting of a central city or cities, and surrounding closely settled territory (urban fringe). Since the maximum O_3 concentrations generally occur downwind of an urbanized area, the downwind sites located outside of the urbanized area boundaries were also used in the trends analyses.

Maps of the appropriate urbanized area are included as part of the discussions on urban area trends. The maps include county and urban area boundaries and were obtained from the Bureau of Census maps, while the city boundaries are the best estimates of the actual city borders. The locations of the monitoring sites shown on the maps are for sites having at least 4 years of data during 1981-1985 and which were used in the trends analyses.

The maps are presented for illustrative purposes to show the spatial distribution of monitoring sites.

Figure 5-1 shows the plotting convention used in trends analyses. For 1981-1985, the maximum and minimum values as well as the composite average of the sites used in the trends are shown. The maximum and minimum values are measured concentrations, while interpolated values for missing years were used to calculate the appropriate average. Table 5-1 shows the air quality statistics used in the trends analyses for the 14 cities. It should also be noted on the TSP trends plots for all cities, except Houston, that the composite averages for 1981-1982 are connected by dotted lines. As previously explained in Section 3.1.1, EPA has found that TSP data collected in 1981 may be biased high due to the glass fiber filter used during these years. The apparent decrease in TSP concentrations between 1981 and 1982 can be partially attributed to a change in the filters. In Houston during 1981 and 1982, a combination of several different types of filters were used which may have resulted in an unknown bias.[2]

The air quality data and trends presented in this section should not be used to make direct city to city comparisons since the mix, configuration, and number of sites comprising the area network are different. Furthermore, other parameters such as population density, transportation patterns, industrial composition, emission sources, and meteorological characteristics also need to be taken into consideration.

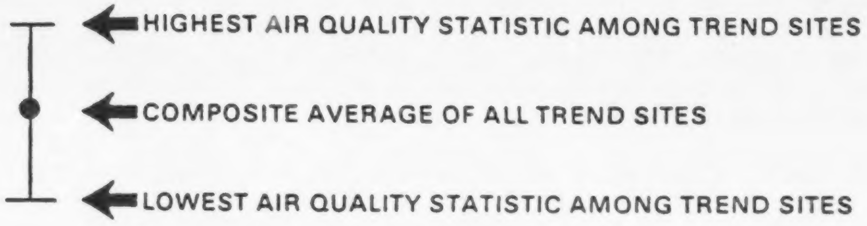

HIGHEST AIR QUALITY STATISTIC AMONG TREND SITES
COMPOSITE AVERAGE OF ALL TREND SITES
LOWEST AIR QUALITY STATISTIC AMONG TREND SITES

FIGURE 5-1. ILLUSTRATION OF PLOTTING CONVENTIONS FOR RANGES USED IN URBANIZED AREA TREND ANALYSIS.

Table 5-1. Air Quality Trend Statistics and Their
Associated National Ambient Air Quality Standards (NAAQS)

POLLUTANT	TREND STATISTICS	PRIMARY NAAQS CONCENTRATION
Total Suspended Particulate	annual geometric mean	75 ug/m^3
Sulfur Dioxide	annual arithmetic mean	0.03 ppm (80 ug/m^3)
Carbon Monoxide	second highest nonoverlapping 8-hour average	9 ppm (10 mg/m^3)
Nitrogen Dioxide	annual arithmetic mean	0.053 ppm (100 ug/m^3)
Ozone	second highest daily maximum 1-hour average	0.12 ppm (235 ug/m^3)
Lead	maximum quarterly average	1.5 ug/m^3

ug/m^3 = micrograms per cubic meter

ppm = parts per million

mg/m^3 = milligrams per cubic meter

5.1 BOSTON, MASSACHUSETTS URBANIZED AREA

Boston is the largest urbanized area in the State of Massachusetts and the eighth largest in the United States with a 1980 population of 2,678,762. It includes all of Suffolk County and the greater portion of Norfolk County plus portions of Plymouth, Middlesex, Essex, and Worcester Counties. The area extends about 51 miles east to west and about 46 miles north to south at the greatest distances.

The Boston basin, a territory within a range of hills, has rolling topographical physical features, and is split by the Charles and Mystic Rivers. Because of the confinement, many tall buildings and light industrial, commercial, and residential land use complexes are in close proximity of each other. Numerous small factories and a great diversification of industries are found in this area including electrical, food, printing and publishing, transportation equipment, fabricated metal, and rubber products. Boston is the chief United States' Atlantic Ocean fishing port. A large network of railroads and truck lines serve this port.

The meteorology of the area is complex. Prevailing winds are from the northwest in the winter and southwest in the summer. During the summer, the land, sea-breeze effect allows pollutants to be transported out over the sea and then returned to the inland area.

The locations of the monitors used in the pollutant trend graphs are provided in Figure 5-2 and 5-3, and the trends graphs are displayed in Figure 5-4.

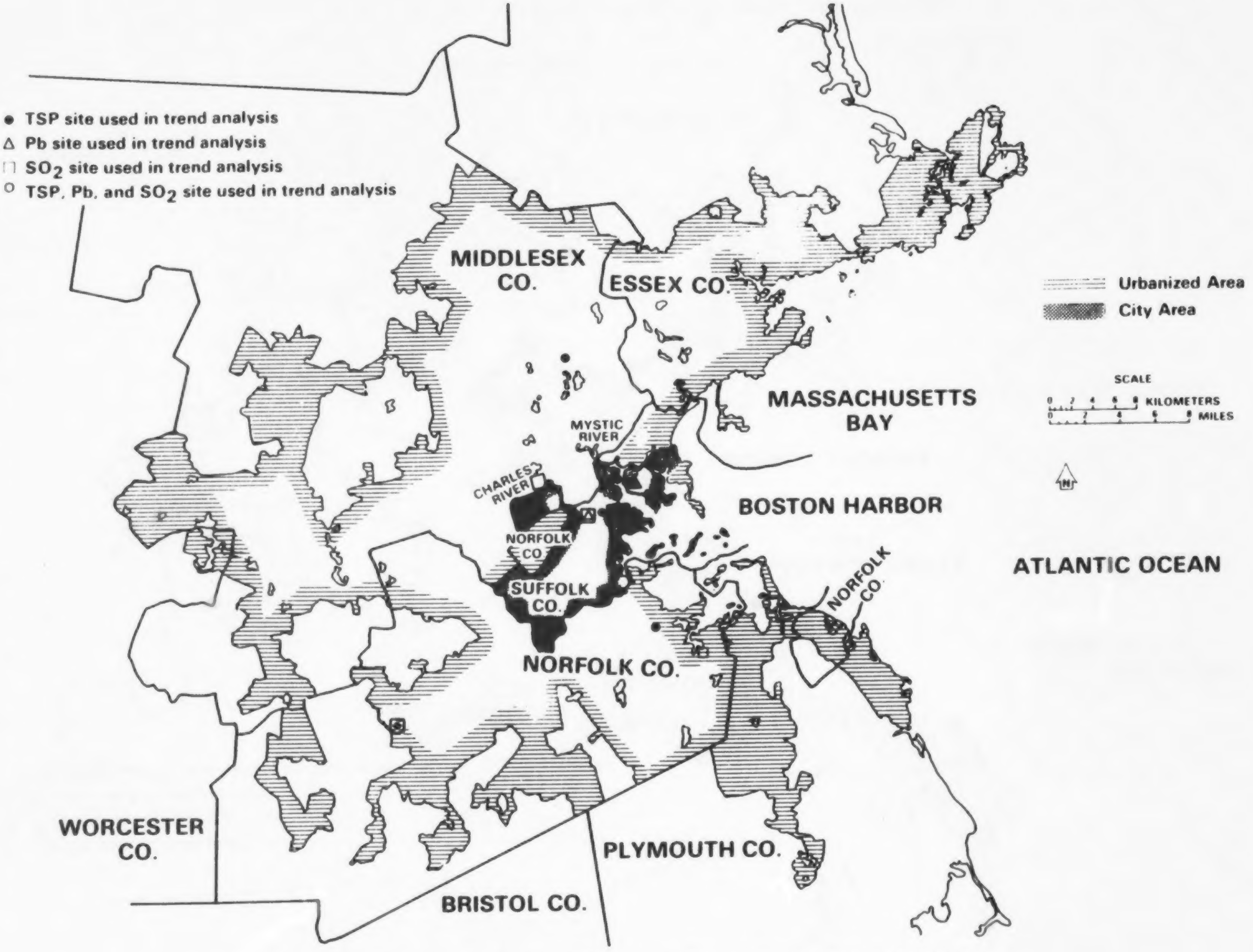

● TSP site used in trend analysis
Δ Pb site used in trend analysis
□ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
MIDDLESEX CO.
ESSEX CO.
MASSACHUSETTS BAY
MYSTIC RIVER
CHARLES RIVER
NORFOLK CO.
SUFFOLK CO.
BOSTON HARBOR
ATLANTIC OCEAN
NORFOLK CO.
NORFOLK CO.
WORCESTER CO.
PLYMOUTH CO.
BRISTOL CO.
Urbanized Area
City Area
SCALE
0 2 4 6 8 KILOMETERS
0 2 4 6 8 MILES
N

Figure 5-2 Location of TSP, Pb, and SO_2 Monitoring Sites in Boston, MA 1981-1985

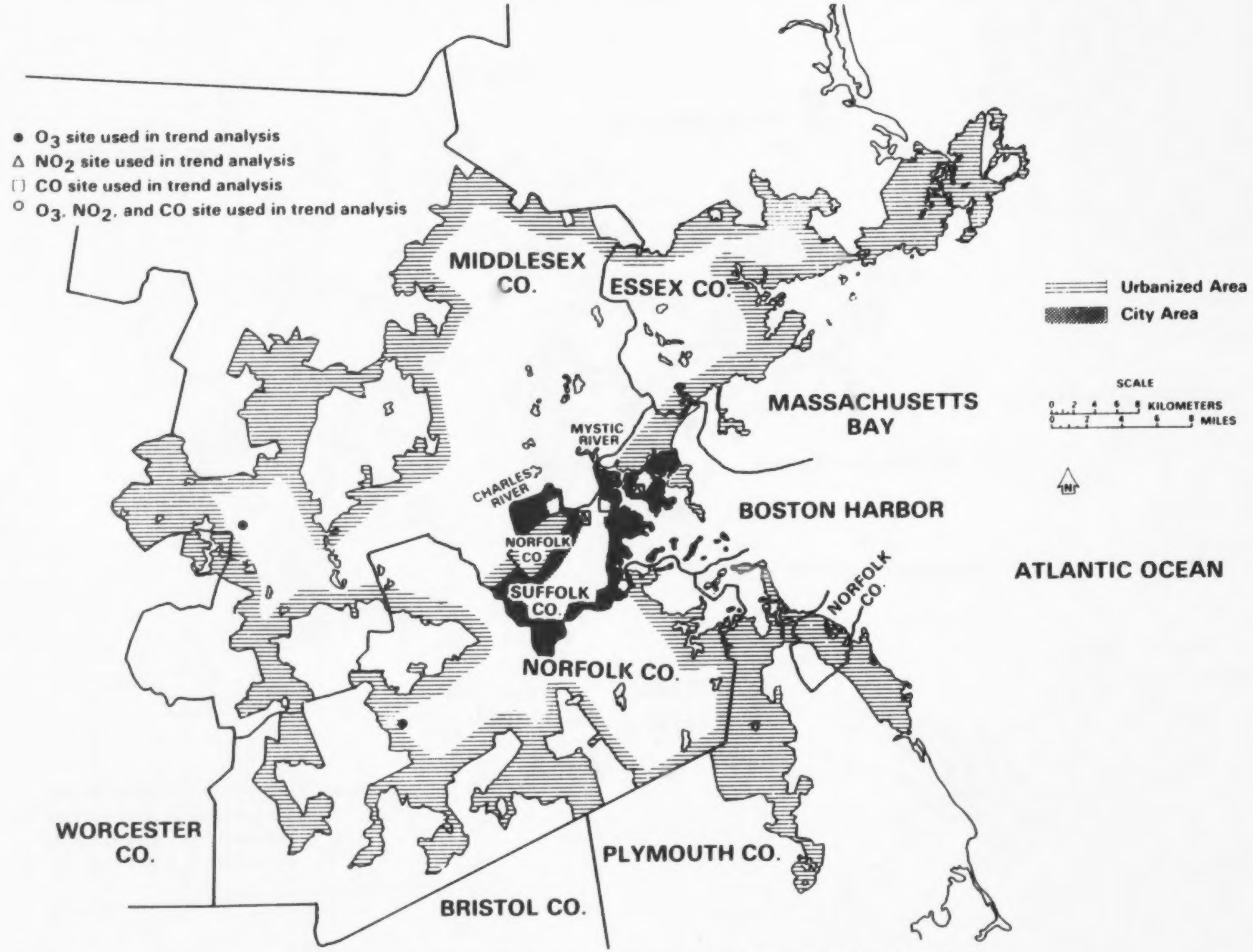

● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
MIDDLESEX CO.
ESSEX CO.
MASSACHUSETTS BAY
MYSTIC RIVER
CHARLES RIVER
NORFOLK CO.
SUFFOLK CO.
BOSTON HARBOR
NORFOLK CO.
NORFOLK CO.
ATLANTIC OCEAN
WORCESTER CO.
PLYMOUTH CO.
BRISTOL CO.
Urbanized Area
City Area
SCALE
0 2 4 6 8 KILOMETERS
0 2 4 6 8 MILES
N

Figure 5 3 Location of O_3, NO_2, and CO Monitoring Sites in Boston, MA 1981 1985

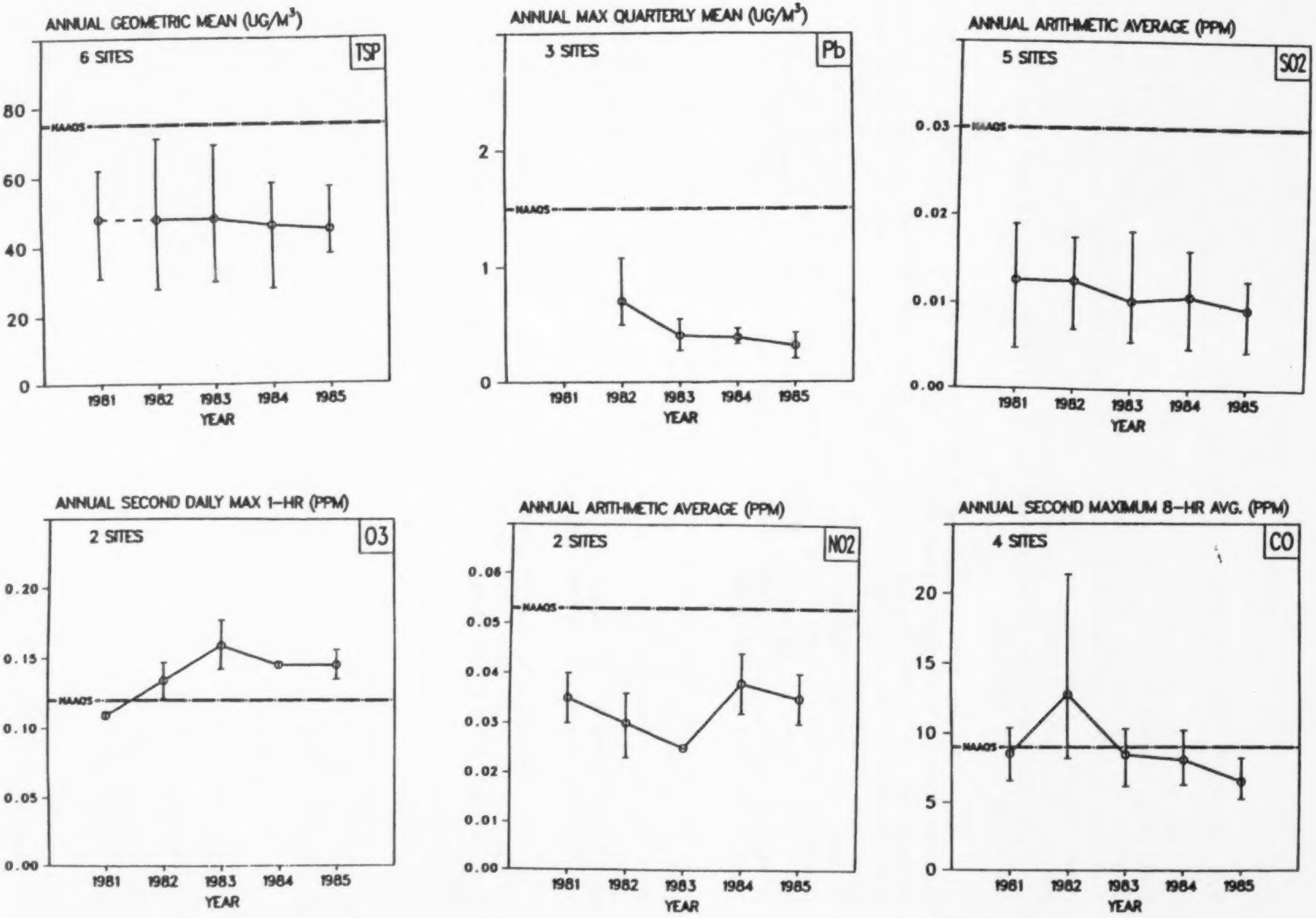


Figure 5-4. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Boston, MA Urbanized Area, 1981-1985.

5.2 NEW YORK, NEW YORK-NORTHEASTERN NEW JERSEY URBANIZED AREA

New York is the largest urbanized area in the United States with a 1980 population of 15,590,274. It includes all of Essex, Hudson, and Union Counties in New Jersey; all of Bronx, Kings, Nassau, New York, Queens, and Richmond Counties in New York; parts of Bergen, Middlesex, Monmonth, Morris, Ocean, Passaic, Somerset, and Sussex Counties in New Jersey; and parts of Putnam, Rockland, Suffolk, and Westchester Counties in New York. At its greatest distance, the area extends about 105 miles east to west and about 110 miles north to south.

The urbanized area is located at the mouth of the Hudson River in the northeastern part of the United States. As a major ocean port, it is the busiest in the United States. Industries have concentrated in the urbanized area because of the proximity to major markets and the easy access to transportation facilites making it the leading manufacturing area in the United States. Its largest manufacturing industries are apparel and other finished products; printing, publishing, and allied industries; food products; machinery; chemical and allied products; fabricated metal products; textile products; leather and leather products; paper products; auto and aircraft production; and shipbuilding.

New York is close to the path of most frontal systems which move across the United States. Extremes of hot weather which may last up to 1 week are associated with air masses moving over land from a Bermuda high pressure system. Extremes in cold weather are from rapidly moving outbreaks of cold air moving southeastward from the Hudson Bay region. The average rainfall is around 41 inches per year.

The maps showing the locations of the monitoring sites used in the trend analysis are shown in Figure 5-5 and Figure 5-6. The trends graphs for the pollutants are shown in Figure 5-7 and depict the trends for 1981-1985.

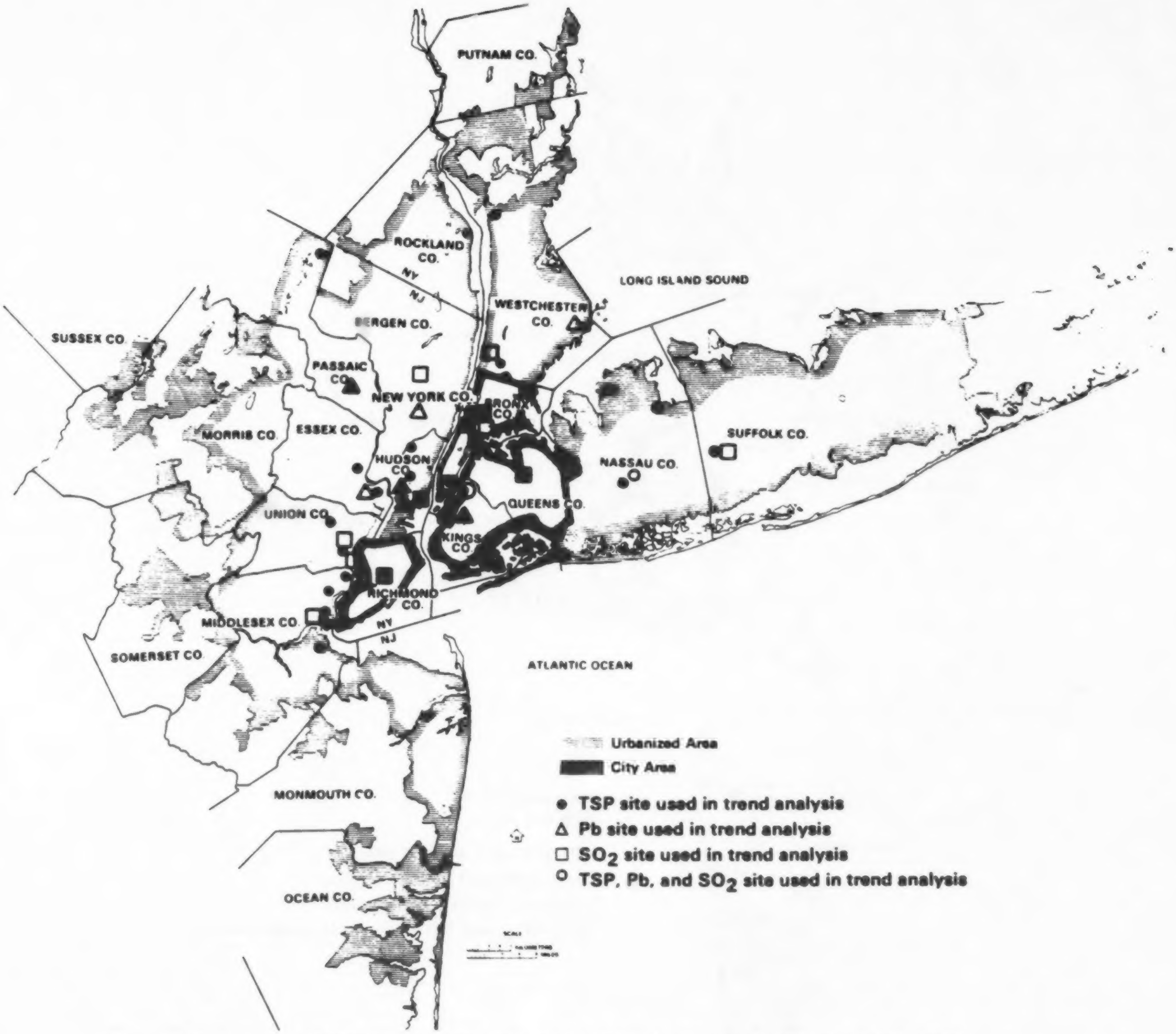
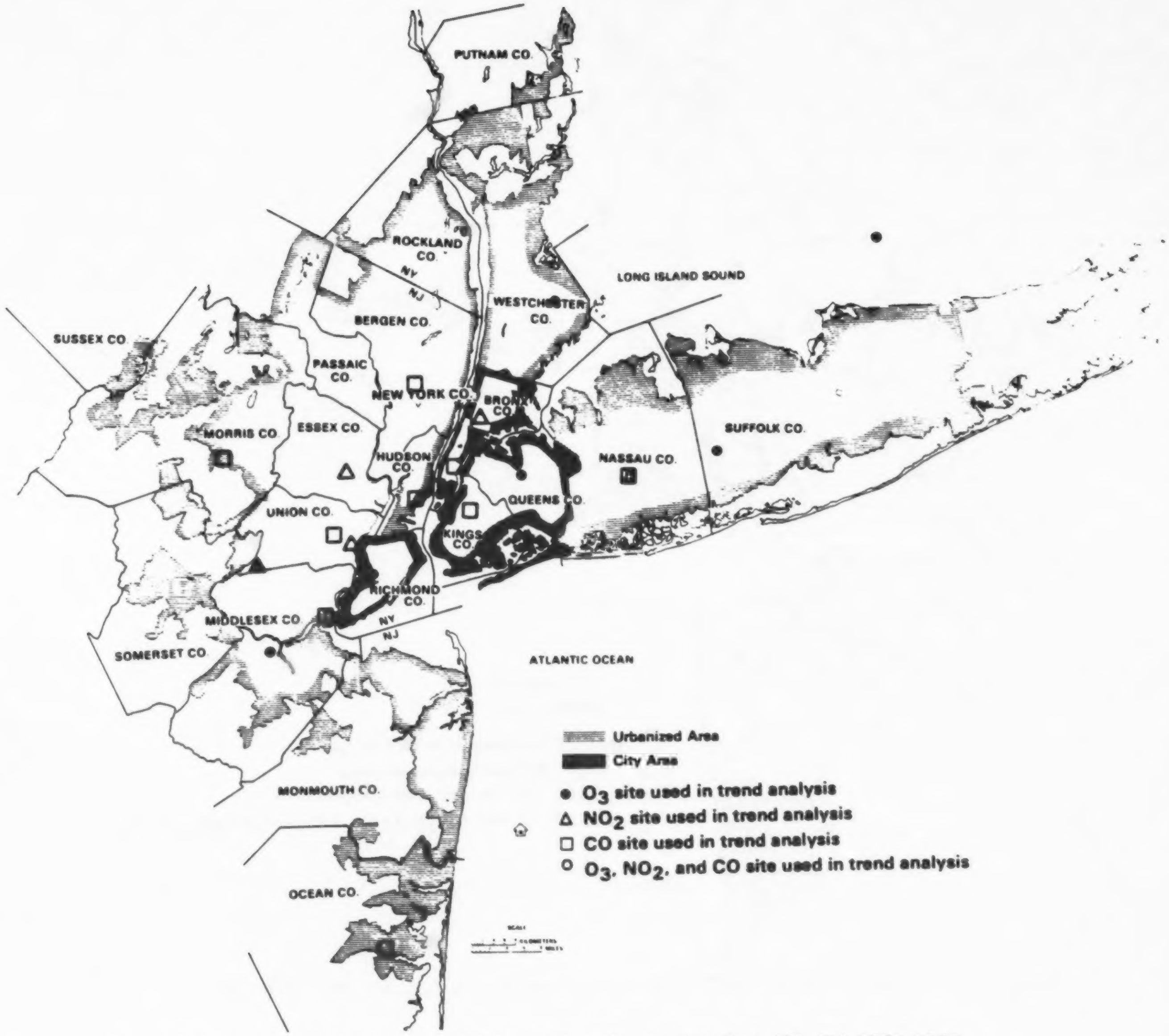

PUTNAM CO.
ROCKLAND CO.
NY
NJ
WESTCHESTER CO.
LONG ISLAND SOUND
SUSSEX CO.
BERGEN CO.
PASSAIC CO.
NEW YORK CO.
BRONX CO.
MORRIS CO.
ESSEX CO.
HUDSON CO.
SUFFOLK CO.
NASSAU CO.
UNION CO.
QUEENS CO.
KINGS CO.
RICHMOND CO.
MIDDLESEX CO.
NY
NJ
SOMERSET CO.
ATLANTIC OCEAN
MONMOUTH CO.
OCEAN CO.
Urbanized Area
City Area
● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO2 site used in trend analysis
○ TSP, Pb, and SO2 site used in trend analysis
SCALE

Figure 5-5. Location of TSP, Pb, and SO_2 Monitoring Sites in New York, NY - NJ 1981-1985



PUTNAM CO.
ROCKLAND CO.
NY
NJ
LONG ISLAND SOUND
WESTCHESTER CO.
BERGEN CO.
SUSSEX CO.
PASSAIC CO.
NEW YORK CO.
BRONX CO.
MORRIS CO.
ESSEX CO.
SUFFOLK CO.
HUDSON CO.
NASSAU CO.
QUEENS CO.
UNION CO.
KINGS CO.
RICHMOND CO.
MIDDLESEX CO.
NY
NJ
SOMERSET CO.
ATLANTIC OCEAN
MONMOUTH CO.
OCEAN CO.
▨ Urbanized Area
■ City Area
● O3 site used in trend analysis
△ NO2 site used in trend analysis
☐ CO site used in trend analysis
○ O3, NO2, and CO site used in trend analysis

Figure 5-6. Location of O_3, NO_2, and CO Monitoring Sites in New York, NY - NJ 1981-1985

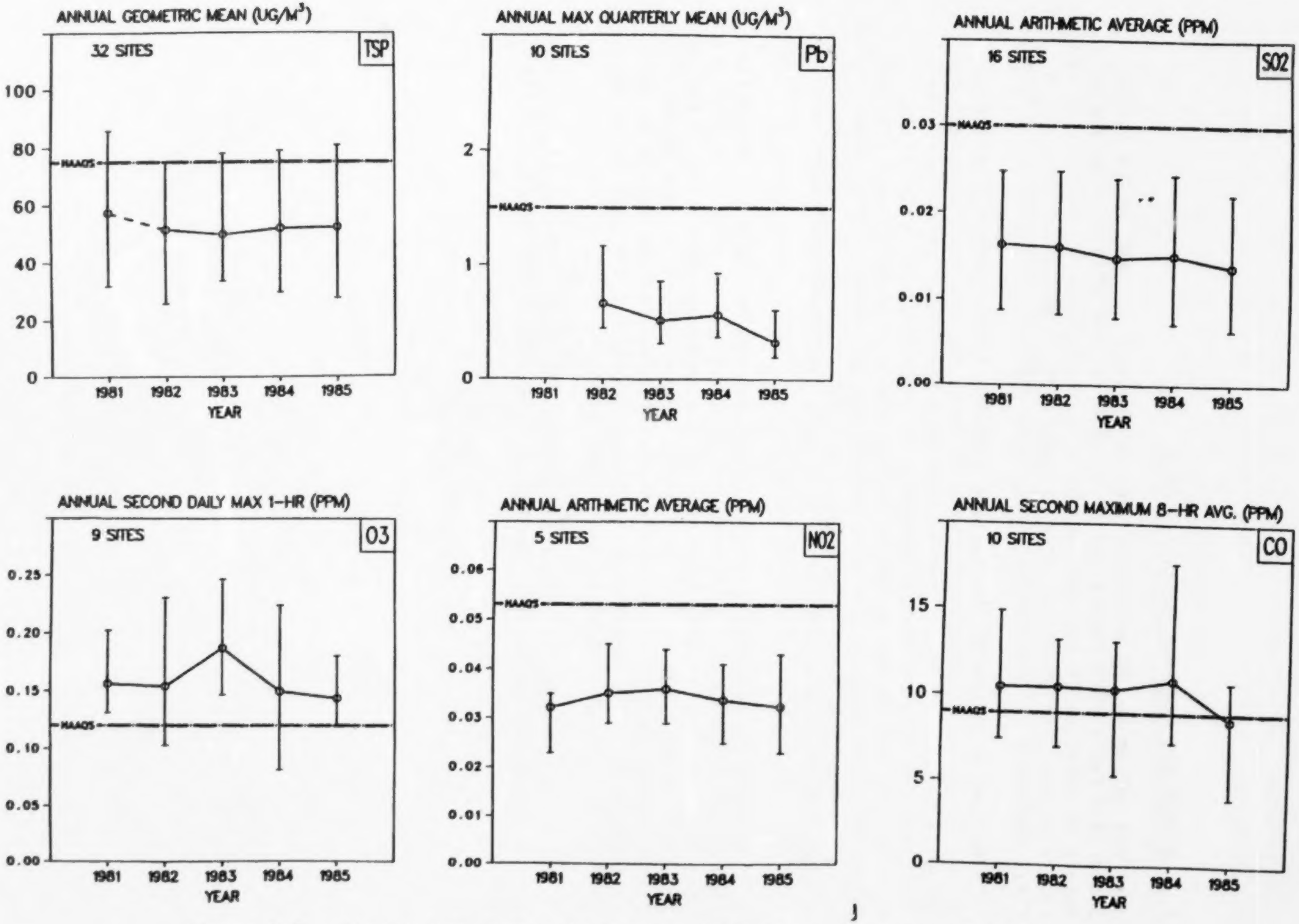


Figure 5-7. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the New York, NY-NJ Urbanized Area, 1981-1985.

5.3 BALTIMORE, MARYLAND URBANIZED AREA

The Baltimore, MD urbanized area is the 14th largest in the United States and had a 1980 population of 1,755,477. The area extends approximately 40 miles north to south and 32 miles east to west and includes 523 square miles. The urbanized area is comprised of Baltimore independent city, and parts of Anne Arundel, Baltimore, Harford, and Howard counties.

Baltimore is one of the busiest seaports in the United States with access to the sea through both the Chesapeake Bay and the Chesapeake and Delaware Canal. It is located farther west than other seaports in the Northeast and because of the economics of lower transportation costs, Baltimore is one of the principal transportation routes between the East Coast and the Midwest. Its major industries are shipbuilding, steel production, chemical and fertilizer production, copper refining, sugar refining, transportation, and production of aluminum, electronic equipment, and numerous other small industrial products.

The area is near the average path of the low pressure systems which move across the country, and cause frequent changes in wind direction which contribute to the variable character of the weather. Mountains to the west and the bay and ocean to the east produce a net effect of more equable climate compared with other continental locations farther inland at the same latitude. The rainfall distribution throughout the year is rather uniform and averages about 43 inches per year.

Figures 5-8 and 5-9 show the locations of the monitoring sites used in the trends analyses, and Figure 5-10 shows the trends graphs for the pollutants.

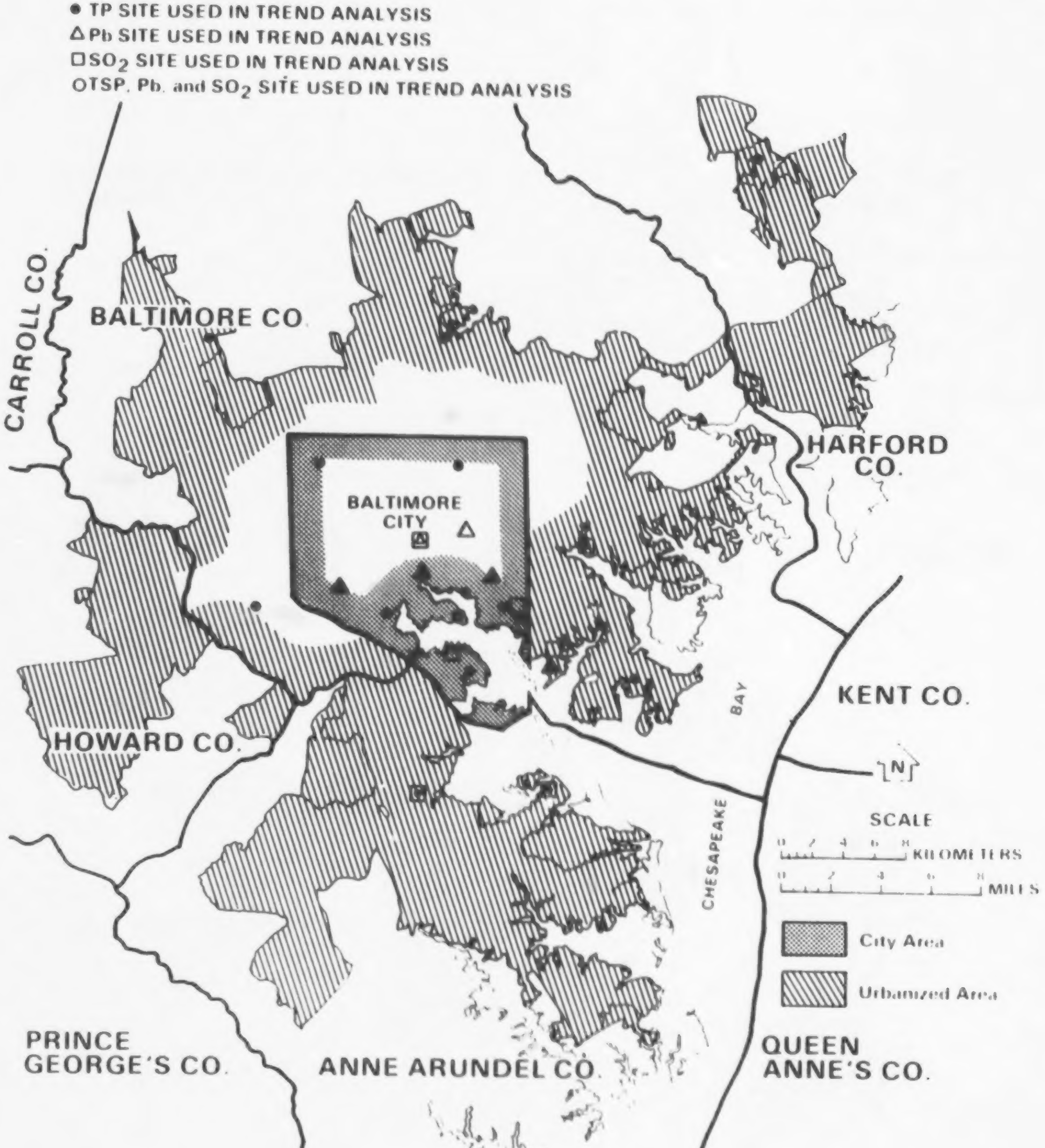

● TP SITE USED IN TREND ANALYSIS
△ Pb SITE USED IN TREND ANALYSIS
□ SO2 SITE USED IN TREND ANALYSIS
○ TSP, Pb, and SO2 SITE USED IN TREND ANALYSIS
CARROLL CO.
BALTIMORE CO.
HARFORD CO.
BALTIMORE CITY
HOWARD CO.
KENT CO.
BAY
CHESAPEAKE
N
SCALE
0 2 4 6 8 KILOMETERS
0 2 4 6 8 MILES
City Area
Urbanized Area
PRINCE GEORGE'S CO.
ANNE ARUNDEL CO.
QUEEN ANNE'S CO.

Figure 5-8. Location of TSP, Pb, and SO_2 Monitoring Sites in Baltimore, MD 1981-1985

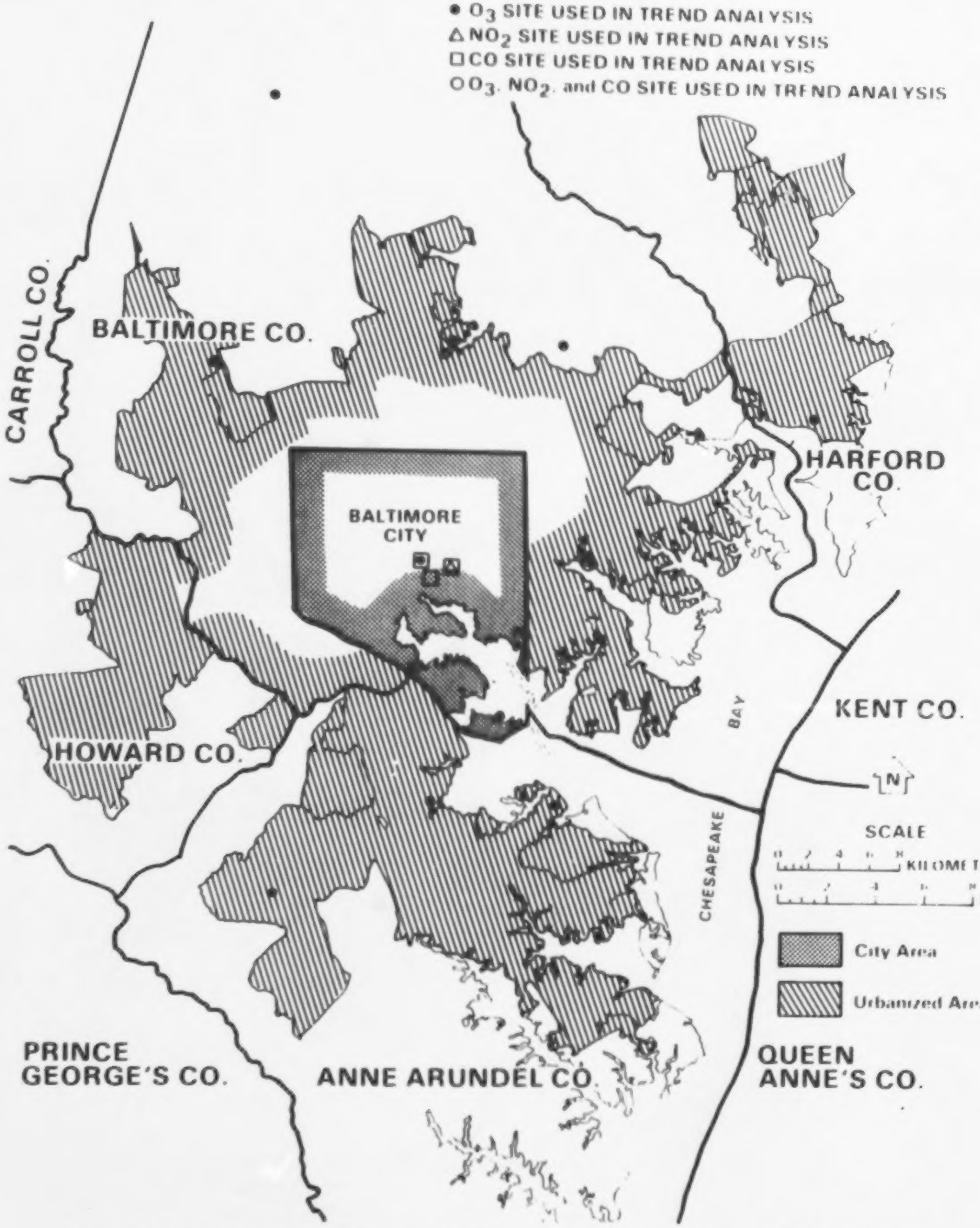

● O_3 SITE USED IN TREND ANALYSIS
△ NO_2 SITE USED IN TREND ANALYSIS
☐ CO SITE USED IN TREND ANALYSIS
○ O_3, NO_2, and CO SITE USED IN TREND ANALYSIS
CARROLL CO.
BALTIMORE CO.
BALTIMORE CITY
HARFORD CO.
HOWARD CO.
KENT CO.
BAY
CHESAPEAKE
N
SCALE
0 2 4 6 8 KILOMETERS
0 2 4 6 8 MILES
City Area
Urbanized Area
PRINCE GEORGE'S CO.
ANNE ARUNDEL CO.
QUEEN ANNE'S CO.

Figure 5.9 Location of O_3, NO_2, and CO Monitoring Sites in Baltimore, MD 1981-1985

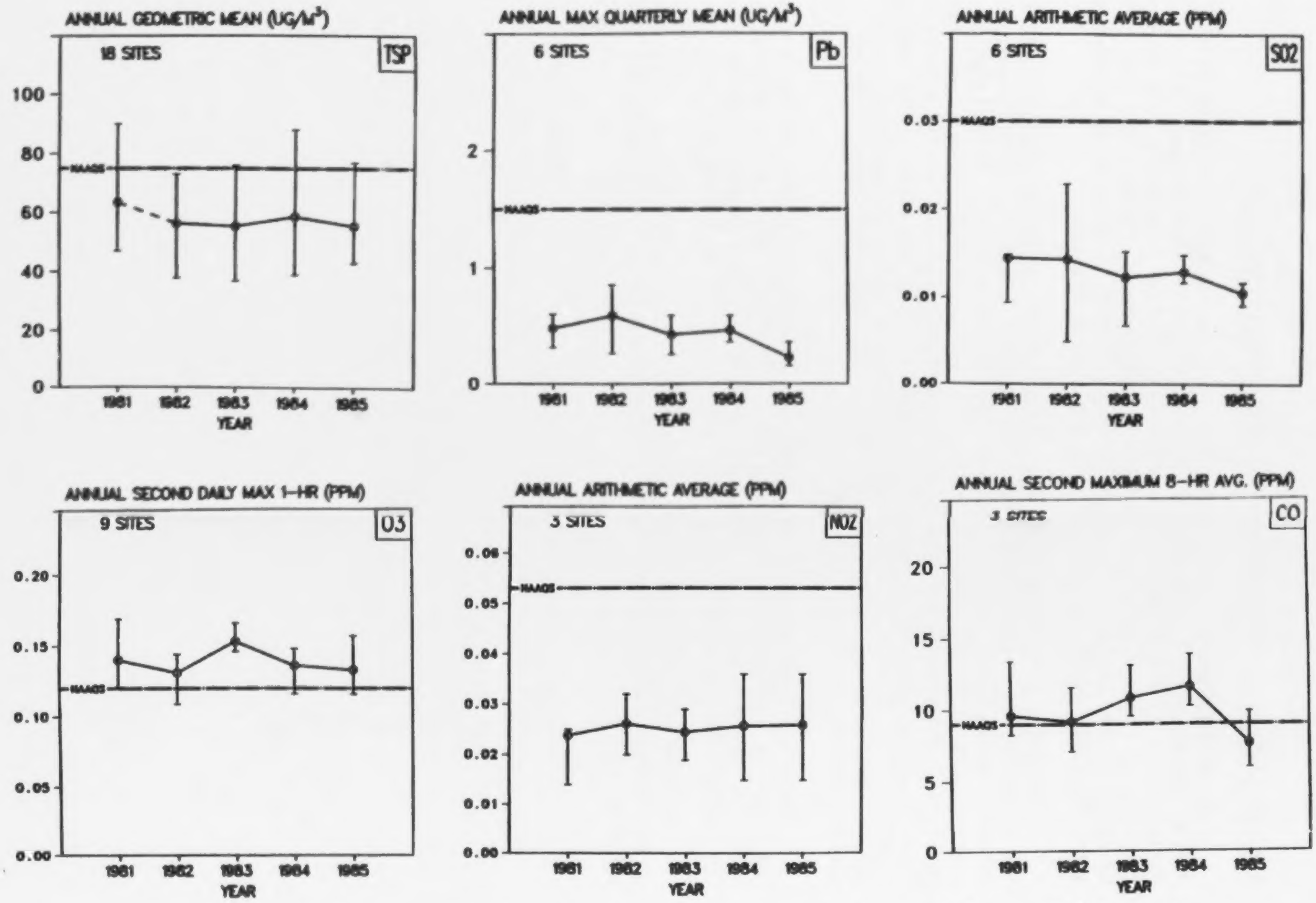


Figure 5-10. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Baltimore, MD Urbanized Area, 1981-1985.

5.4 PHILADELPHIA, PENNSYLVANIA-NEW JERSEY URBANIZED AREA

The Philadelphia, PA-NJ urbanized area is the fourth largest in the United States,with a 1980 population of 4,112,933. It includes all of Philadelphia County plus portions of Bucks, Chester, Delaware, and Montgomery Counties in Pennsylvania and portions of Burlington, Camden, and Gloucester Counties in New Jersey. The area stretches about 65 miles east to west and about 50 miles north to south at its greatest distances.

Philadelphia is located in the southeastern corner of Pennsylvania on the Delaware River where the Schuylkill River flows into the Delaware. The Atlantic Ocean is 85 to 90 miles down the Delaware River. Philadelphia handles more shipping than any other port in the United States except for New York. The industrial growth of Philadelphia was due to its proximity to coal, petroleum, water power, and other natural resources. The leading industries in Philadelphia are manufacturing of textiles, carpets, clothing, paper, chemicals, glassware, oil refining, metalworking, ship building, sugar refining, printing, and publishing.

The prevailing winds of the area are from the southwest in the summer and from the northwest during the winter. Maritime air and the proximity to the Delaware River contribute to high humidity and temperatures during the summer months. The average rainfall is around 42 inches per year.

Figures 5-11 and 5-12 show the locations of the monitoring sites used in the trends analyses, and Figure 5-13 depicts the trends graphs for the pollutants.

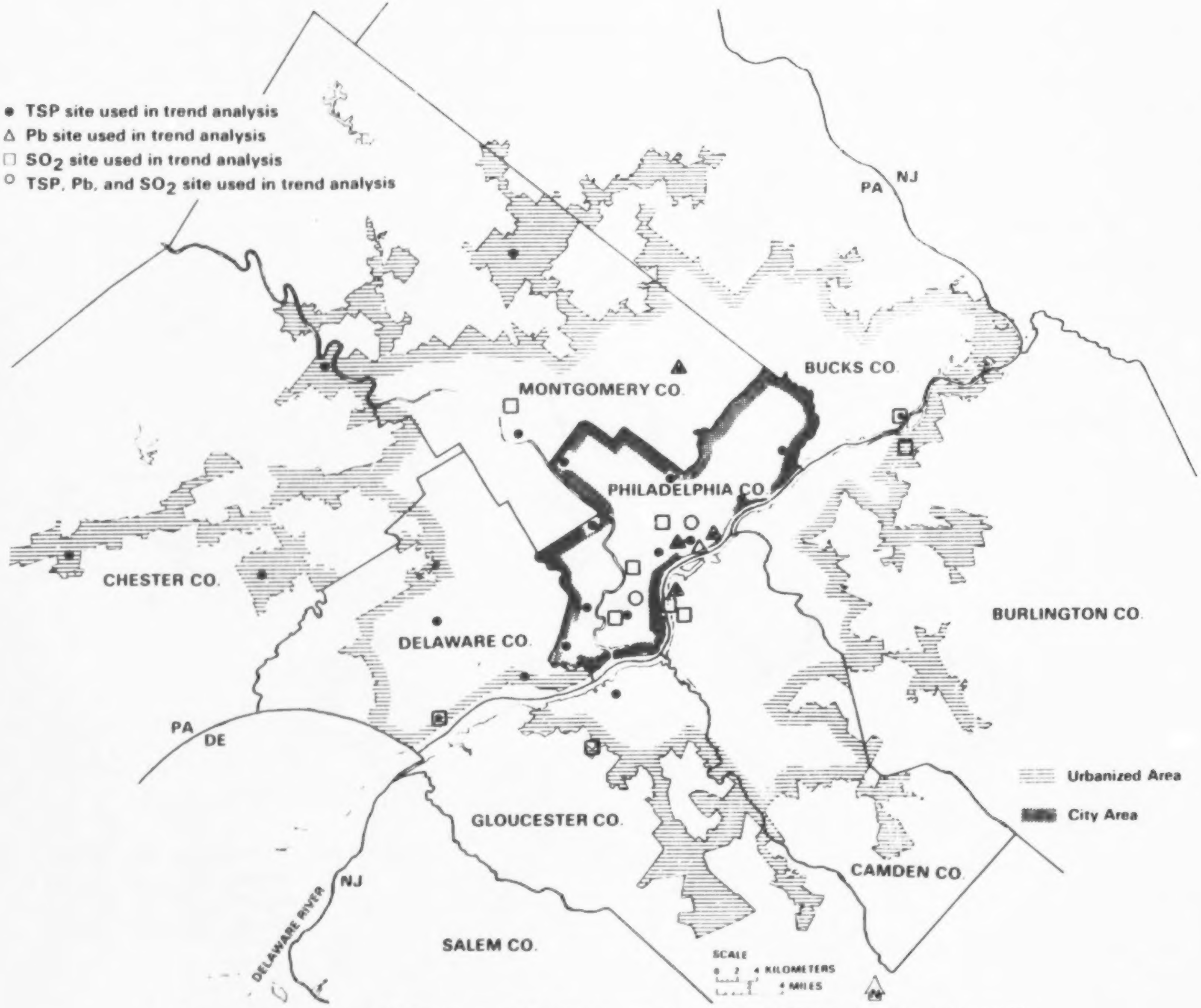

● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO2 site used in trend analysis
○ TSP, Pb, and SO2 site used in trend analysis
PA
NJ
BUCKS CO.
MONTGOMERY CO.
PHILADELPHIA CO.
CHESTER CO.
DELAWARE CO.
BURLINGTON CO.
PA
DE
GLOUCESTER CO.
CAMDEN CO.
NJ
DELAWARE RIVER
SALEM CO.
Urbanized Area
City Area
SCALE
0 2 4 KILOMETERS
4 MILES

Figure 5-11 Location of TSP, Pb, and SO_2 Monitoring Sites in Philadelphia, PA - NJ 1981-1985

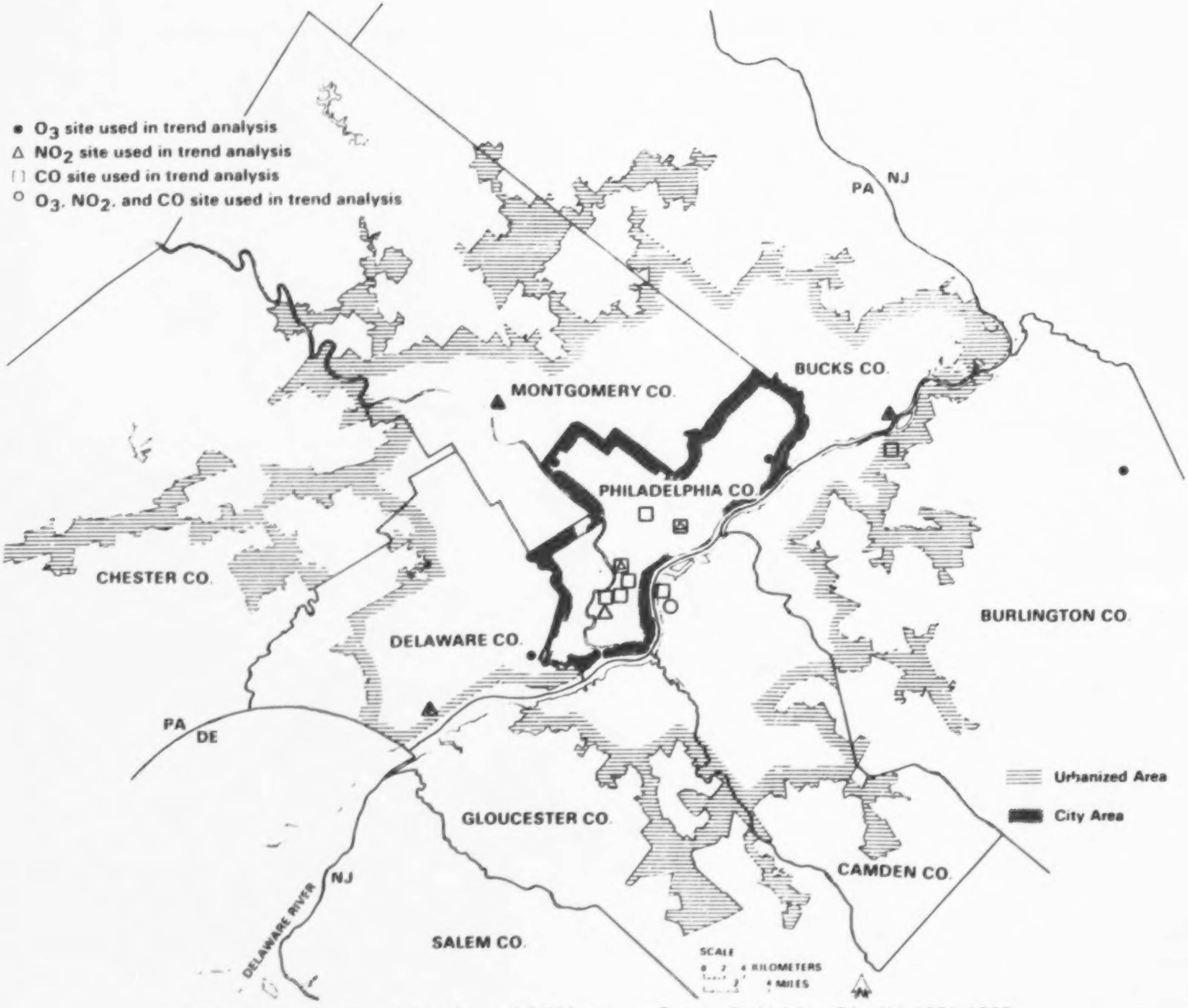

● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
PA
NJ
BUCKS CO.
MONTGOMERY CO.
PHILADELPHIA CO.
CHESTER CO.
DELAWARE CO.
BURLINGTON CO.
PA
DE
GLOUCESTER CO.
CAMDEN CO.
SALEM CO.
NJ
DELAWARE RIVER
Urbanized Area
City Area
SCALE
0 2 4 KILOMETERS
0 2 4 MILES
N

Figure 5-12 Location of O_3, NO_2, and CO Monitoring Sites in Phildelphia, PA - NJ 1981-1985

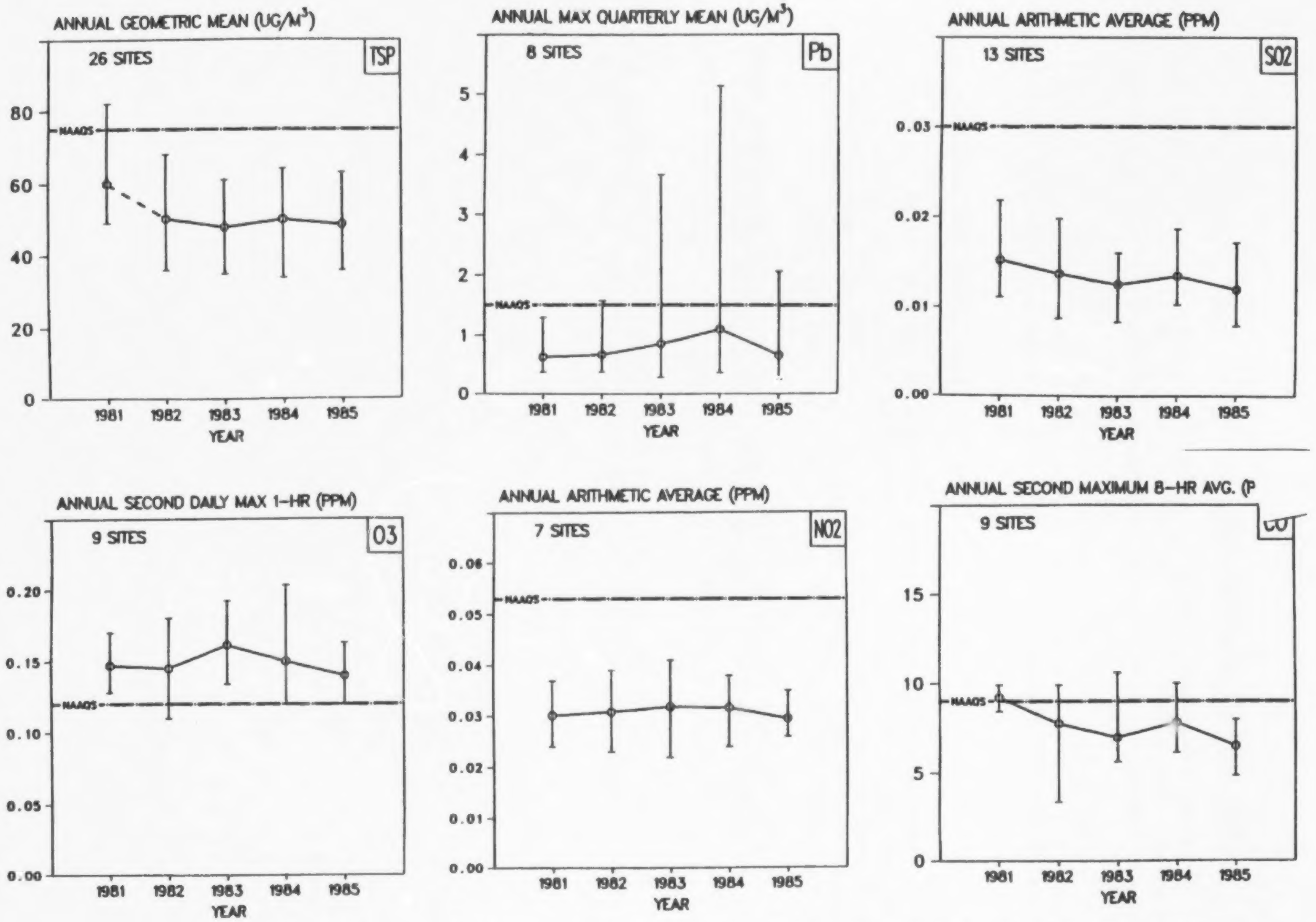


Figure 5-13. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Philadelphia, PA-NJ Urbanized Area, 1981-1985.

5.5 ATLANTA, GEORGIA URBANIZED AREA

Atlanta, the capital of Georgia and its largest city, is located in the north-central part of the State. The urbanized area is the most populous between Washington, D.C. and New Orleans with a 1980 population of 1,613,357. The area extends into ten counties and measures approximately 40 miles north to south and 35 miles east to west. The majority of the people in the urbanized area live in Fulton, de Kalb, and Cobb Counties. Approximately 500 square miles of land area are included in this urbanized area.

The city is the financial and commerical capital of the Southeast, the transportation and commercial center of the region, and an important distribution, manufacturing, educational, and medical center. Since its location is at the southern extreme of the Appalachian Range, it has become the gateway through which most overland and air traffic must pass from the Eastern Seaboard to the West. Atlanta is a rapidly growing and expanding area. The population increased by 37 percent between 1970 and 1980.

Atlanta has moderate summer and winter weather, with the summer winds from the northwest and the winter winds fluctuating from southwest to northwest. In spite of abundant rainfall, serious dry spells occur during most years.

The locations of the monitors used in the pollutant trends graphs are provided in Figures 5-14 and 5-15. The trends graphs are shown in Figure 5-16.

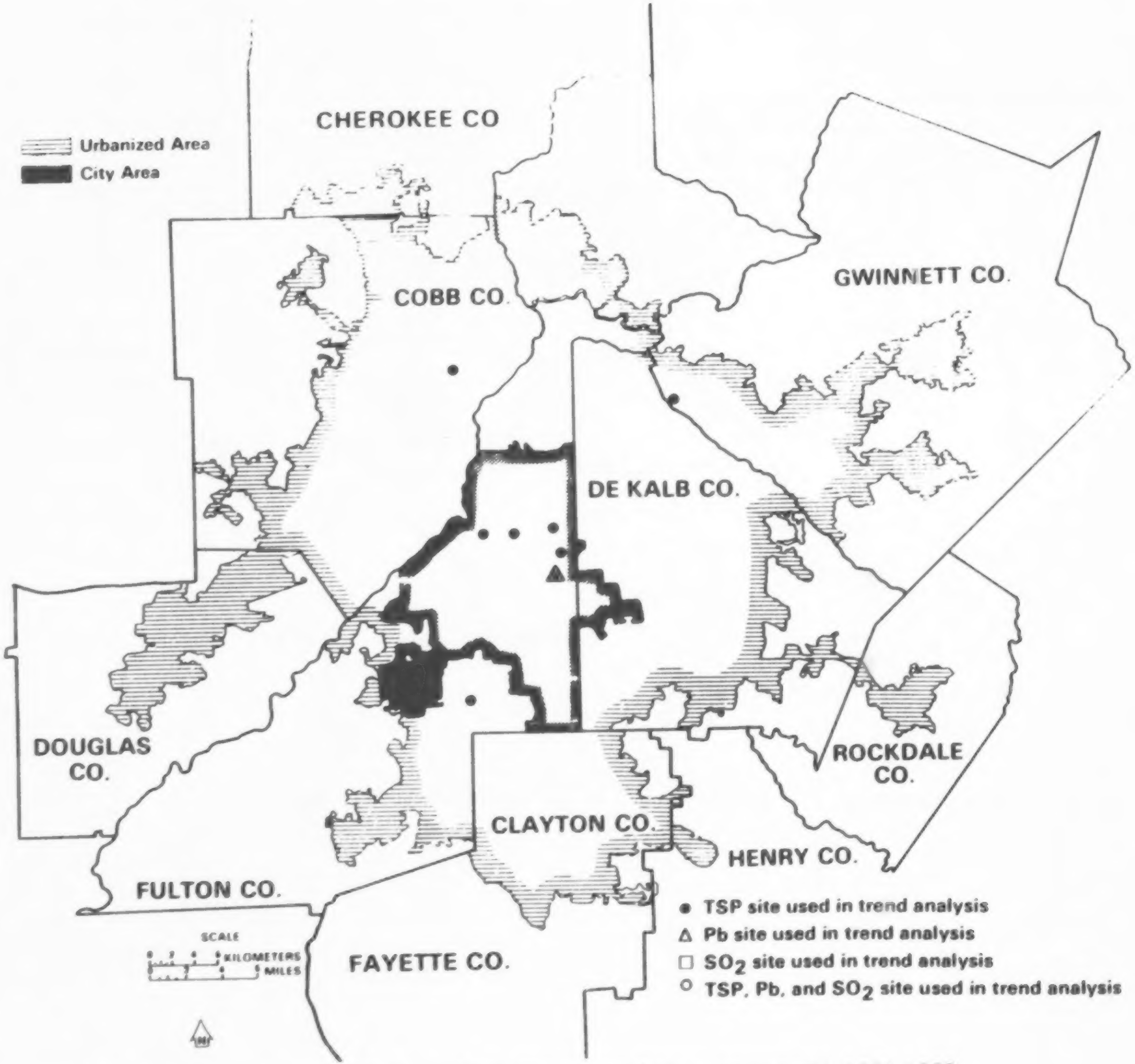

Urbanized Area
City Area
CHEROKEE CO
COBB CO.
GWINNETT CO.
DE KALB CO.
DOUGLAS CO.
ROCKDALE CO.
CLAYTON CO.
HENRY CO.
FULTON CO.
FAYETTE CO.
SCALE
KILOMETERS
MILES
● TSP site used in trend analysis
△ Pb site used in trend analysis
☐ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis

Figure 5-14 Location of TSP, Pb, and SO_2 Monitoring Sites in Atlanta, GA 1981-1985

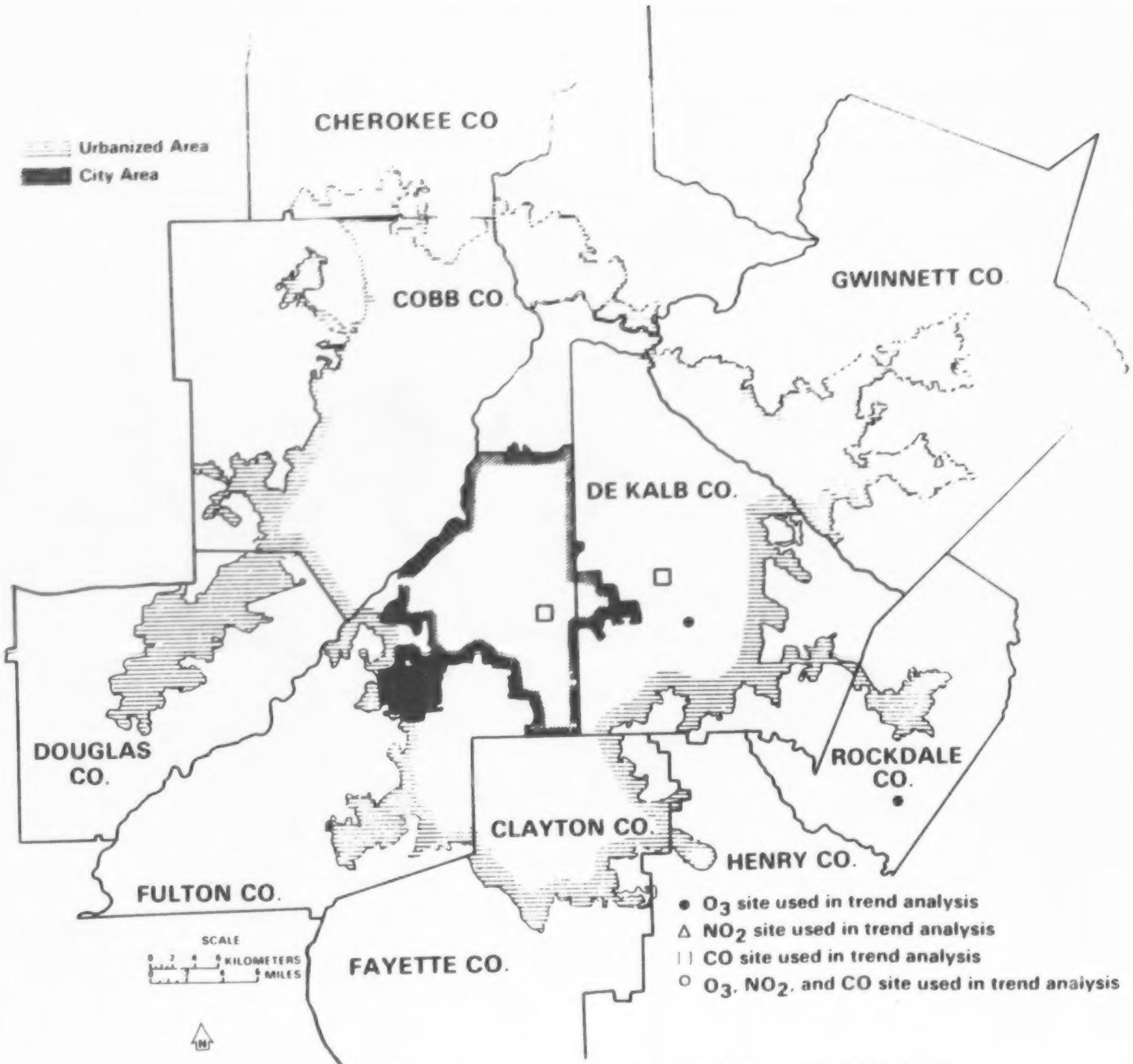

Urbanized Area
City Area
CHEROKEE CO
COBB CO.
GWINNETT CO.
DE KALB CO.
DOUGLAS CO.
ROCKDALE CO.
CLAYTON CO.
HENRY CO.
FULTON CO.
FAYETTE CO.
SCALE
KILOMETERS
MILES
N
● O_3 site used in trend analysis
Δ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis

Figure 5 15 Location of O_3, NO_2, and CO Monitoring Sites in Atlanta, GA 1981 1985

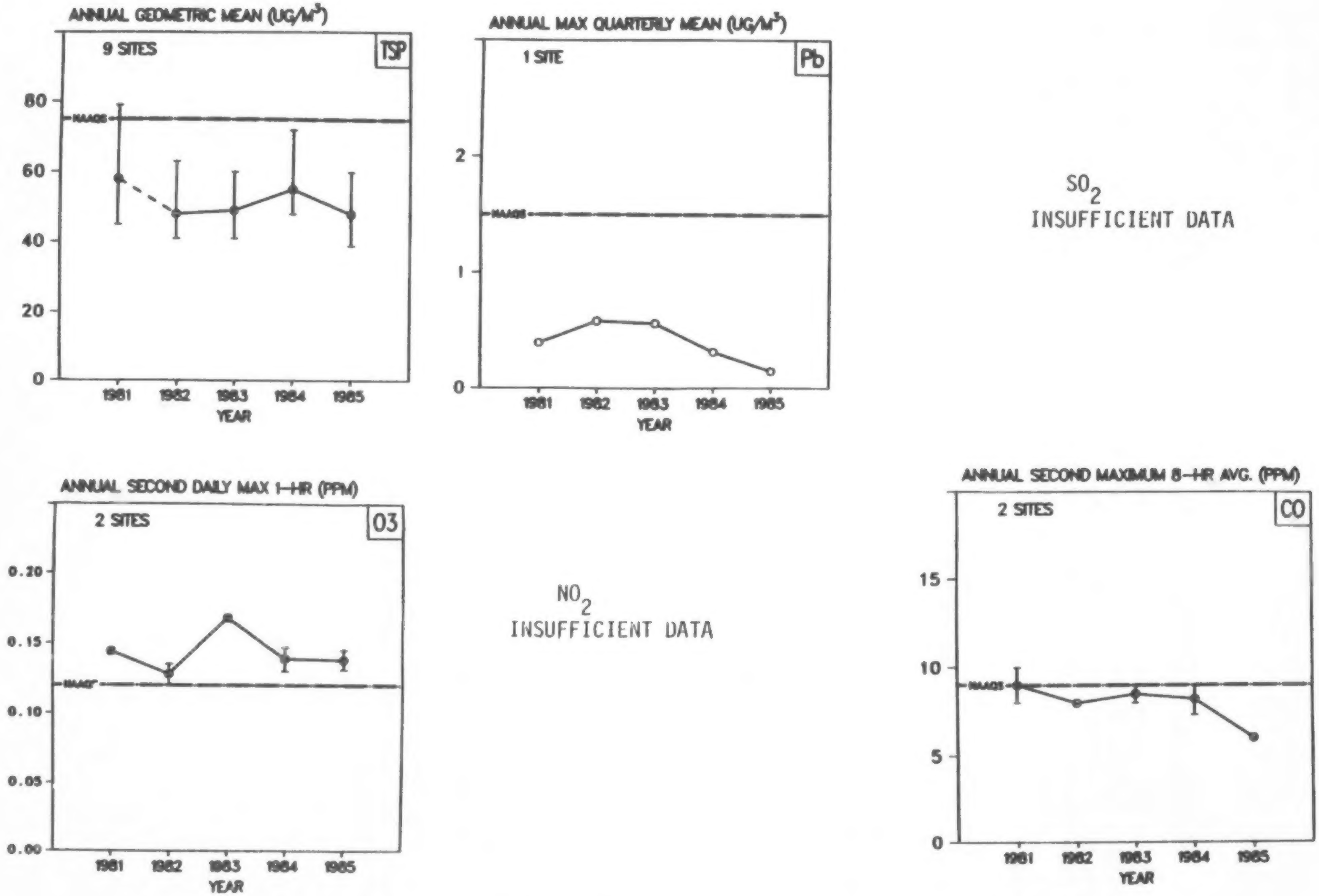


Figure 5-16. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Atlanta, GA Urbanized Area, 1981-1985.

5.6 CHICAGO, ILLINOIS-NORTHWESTERN INDIANA URBANIZED AREA

The Chicago urbanized area covers approximately 1300 square miles and includes 6,770,000 people. It is the third largest area in the nation in terms of population with approximately 75 percent of the population living in Cook County, the remaining 25 percent live in parts of Lake, Du Page and Will Counties in Illinois and portions of Lake and Porter Counties in Indiana.

The urbanized area runs from Waukegan (near the Wisconsin border) around Lake Michigan to Chesterton, Indiana to the east. The southern and western boundaries of the area are very irregular. To the south the area extends as far as Crown Point, Indiana and Park Forest South in Illinois. Similarly, the urban area extends as far west as Bartlett, West Chicago, and Napierville, all in Illinois.

Economically, Chicago is a major center for transportation, manufacturing, and commercial enterprises. In terms of transportation, Chicago has the largest air and rail traffic in the country. Because of Chicago's location and large manufacturing concerns, it has developed an extensive highway network for local and through traffic. Additionally, the port of Chicago on Lake Michigan has developed into an important inland port for raw materials and port of transfer for the Great Lakes-Atlantic trade. Among Chicago's chief manufactures are food products, primary metals (steel) and both elecrical and nonelectrical machinery.

Chicago occupies a relatively flat plains area bounded by Lake Michigan in the east. The climate is predominately continental with relatively warm summers and cold winters. Temperature extremes are somewhat altered by Lake Michigan and other Great Lakes. Annual precipitation is on the order of 33 inches per year.

Figures 5-17 and 5-18 show the locations of the monitors used in the trends analyses and Figure 5-19 shows the trends for all the pollutants in the urbanized area.

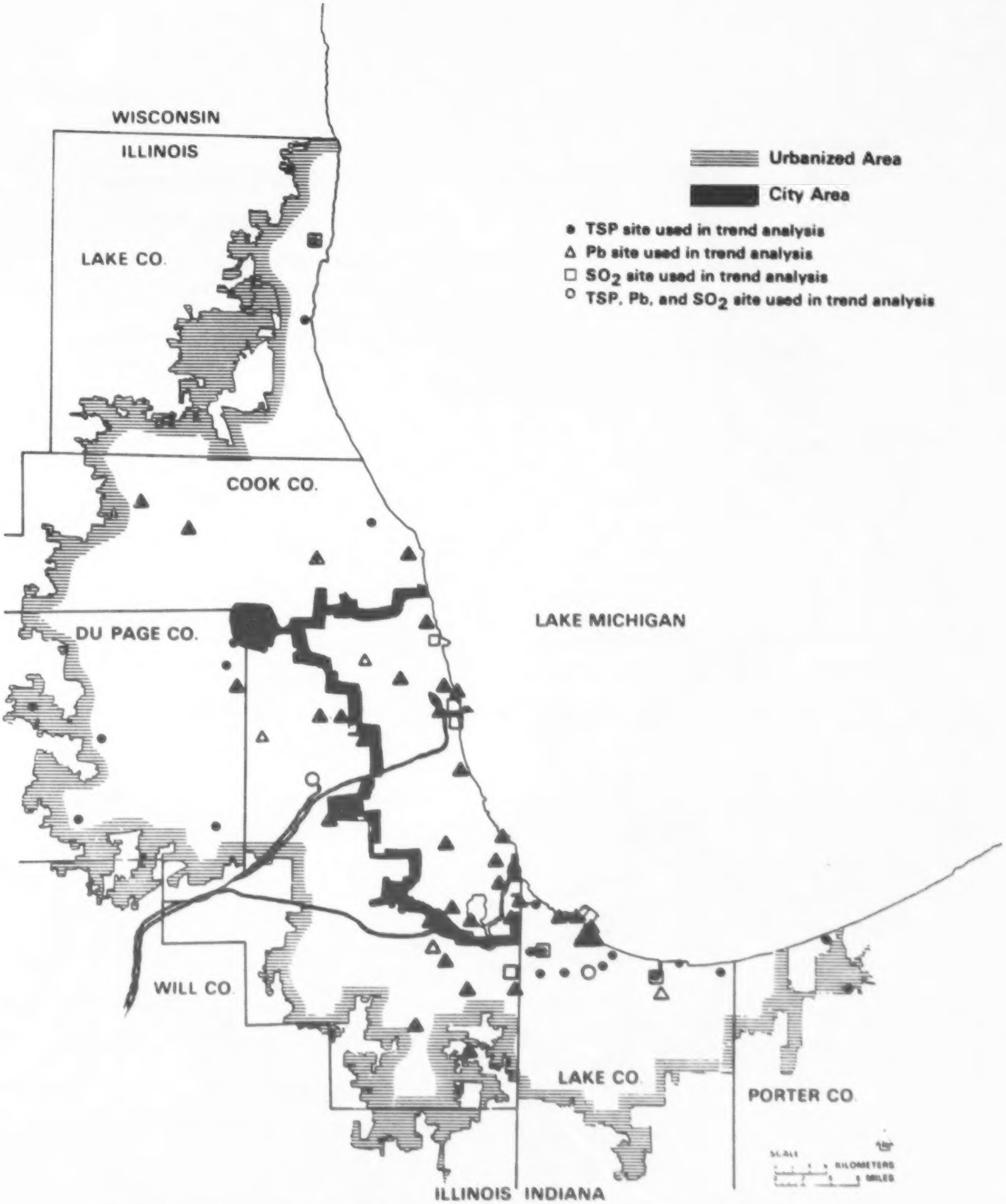

WISCONSIN
ILLINOIS
LAKE CO.
COOK CO.
DU PAGE CO.
WILL CO.
LAKE MICHIGAN
LAKE CO.
PORTER CO.
ILLINOIS
INDIANA
Urbanized Area
City Area
● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
SCALE
KILOMETERS
MILES

Figure 5-17. Location of TSP, Pb, and SO_2 Monitoring Sites in Chicago, IL - IN 1981-1985

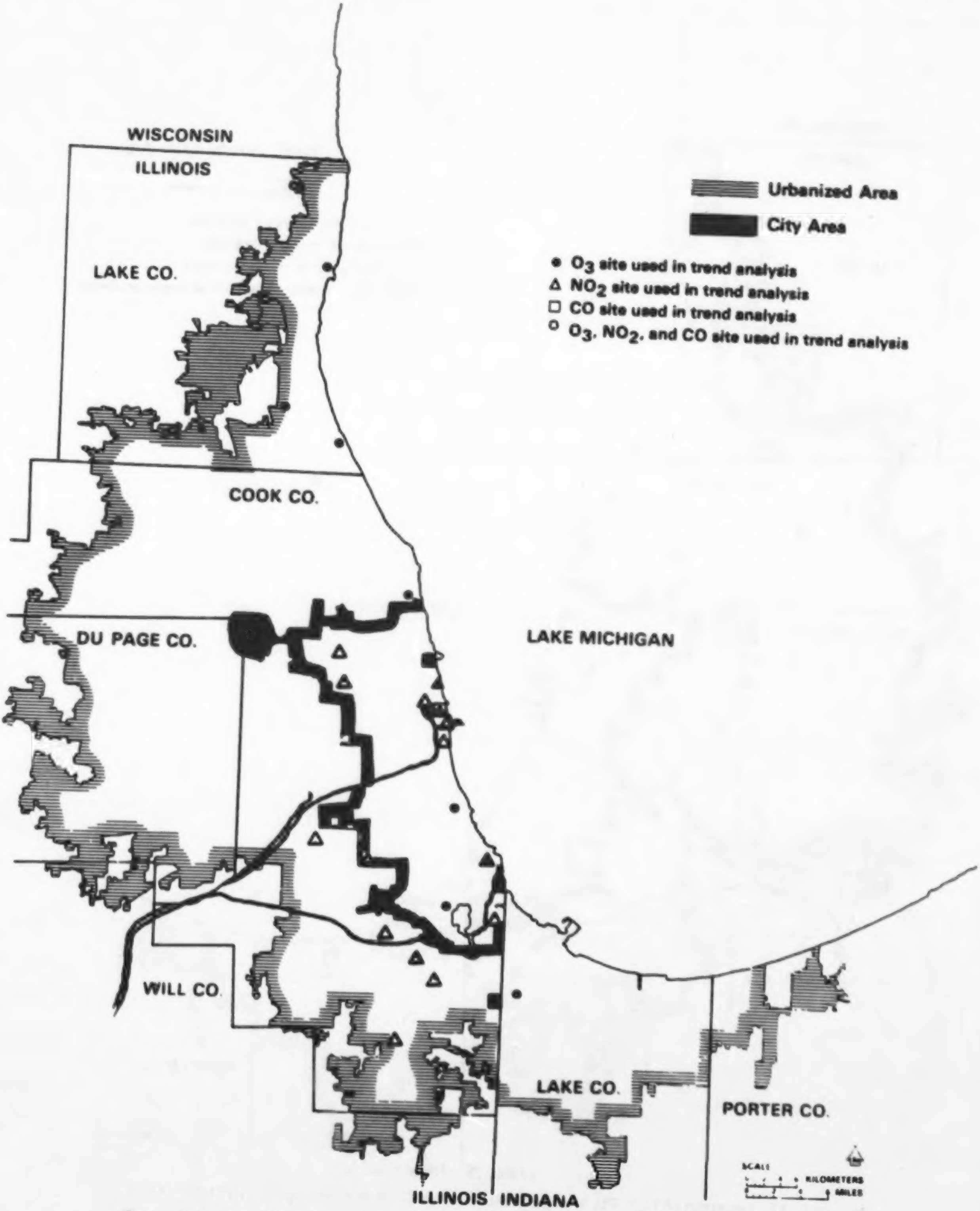

WISCONSIN
ILLINOIS
▤ Urbanized Area
■ City Area
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
LAKE CO.
COOK CO.
DU PAGE CO.
LAKE MICHIGAN
WILL CO.
LAKE CO.
PORTER CO.
SCALE
KILOMETERS
MILES
ILLINOIS
INDIANA

Figure 5-18. Location of O_3, NO_2, and CO Monitoring Sites in Chicago, IL - IN 1981-1985

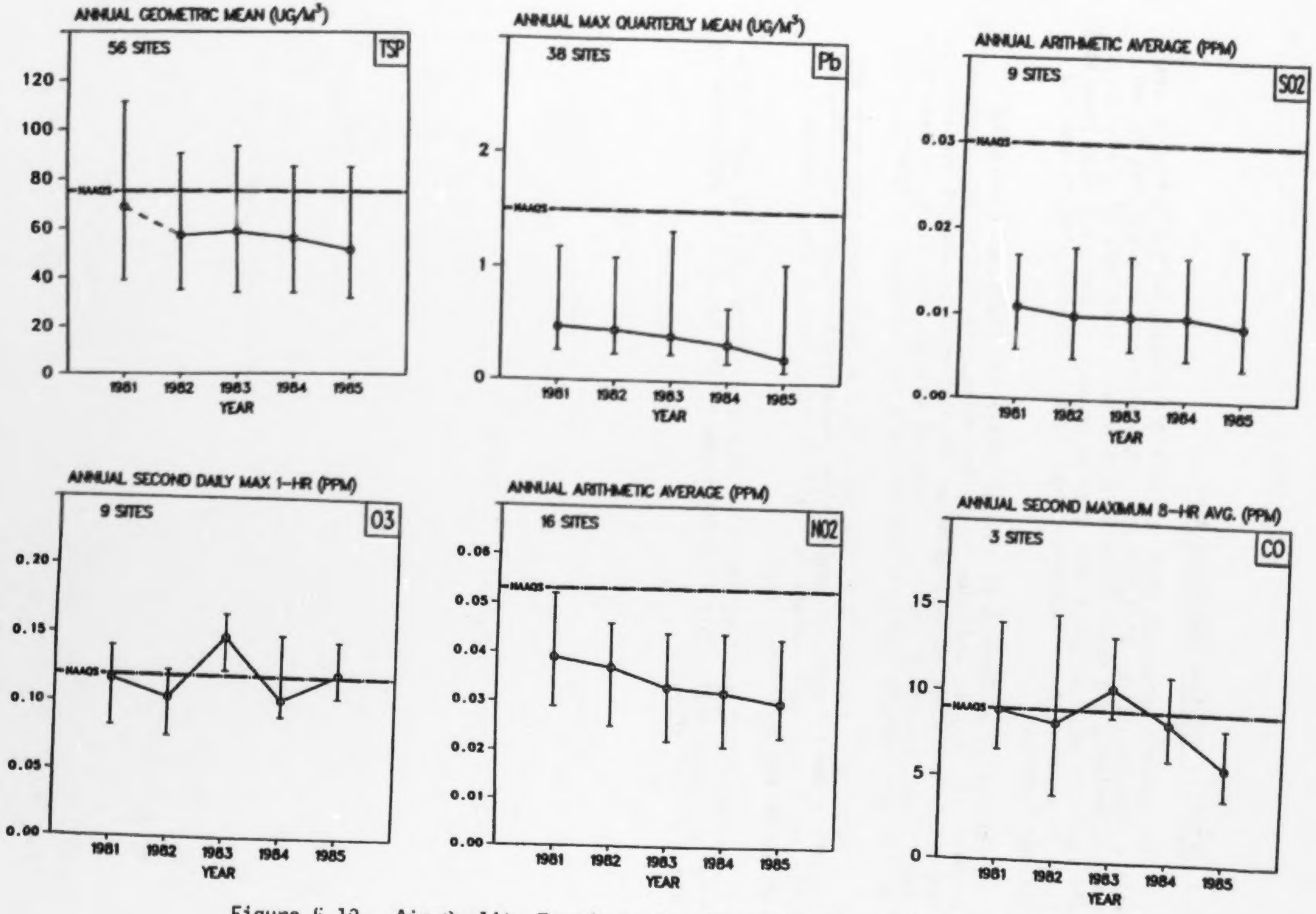


Figure 5-19. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Chicago, IL-IN Urbanized Area, 1981-1985.

5.7 DETROIT, MICHIGAN URBANIZED AREA

The Detroit urbanized area is the fifth largest in the United States with a 1980 population of 3,809,327. The urbanized area includes Macomb, Monroe, Oakland, and Wayne Counties with a total land area of approximately 870 square miles. Slightly less than 60 percent of the urban area population lives in Wayne with the remainder about equally divided among Macomb and Oakland Counties.

Economically, Detroit is a major center for the manufacturing of automobiles, trucks, and other heavy equipment. As such it has developed iron and steel facilities as well as other manufacturing to support the principal industries. Because of Detroit's location between Lake Huron and Lake Erie and its manufactured goods, it has become a major seaport in foreign trade.

Detroit is located in a relatively flat plain between Lake Huron and Lake Erie which serves to moderate the predominately continental climate with relatively warm summers and cold winters. Annual precipitation is approximately 31 inches per year.

Figures 5-20 and 5-21 show the locations of the monitors used in the trends analyses and Figure 5-22 shows the trends for all the pollutants in the urbanized area.

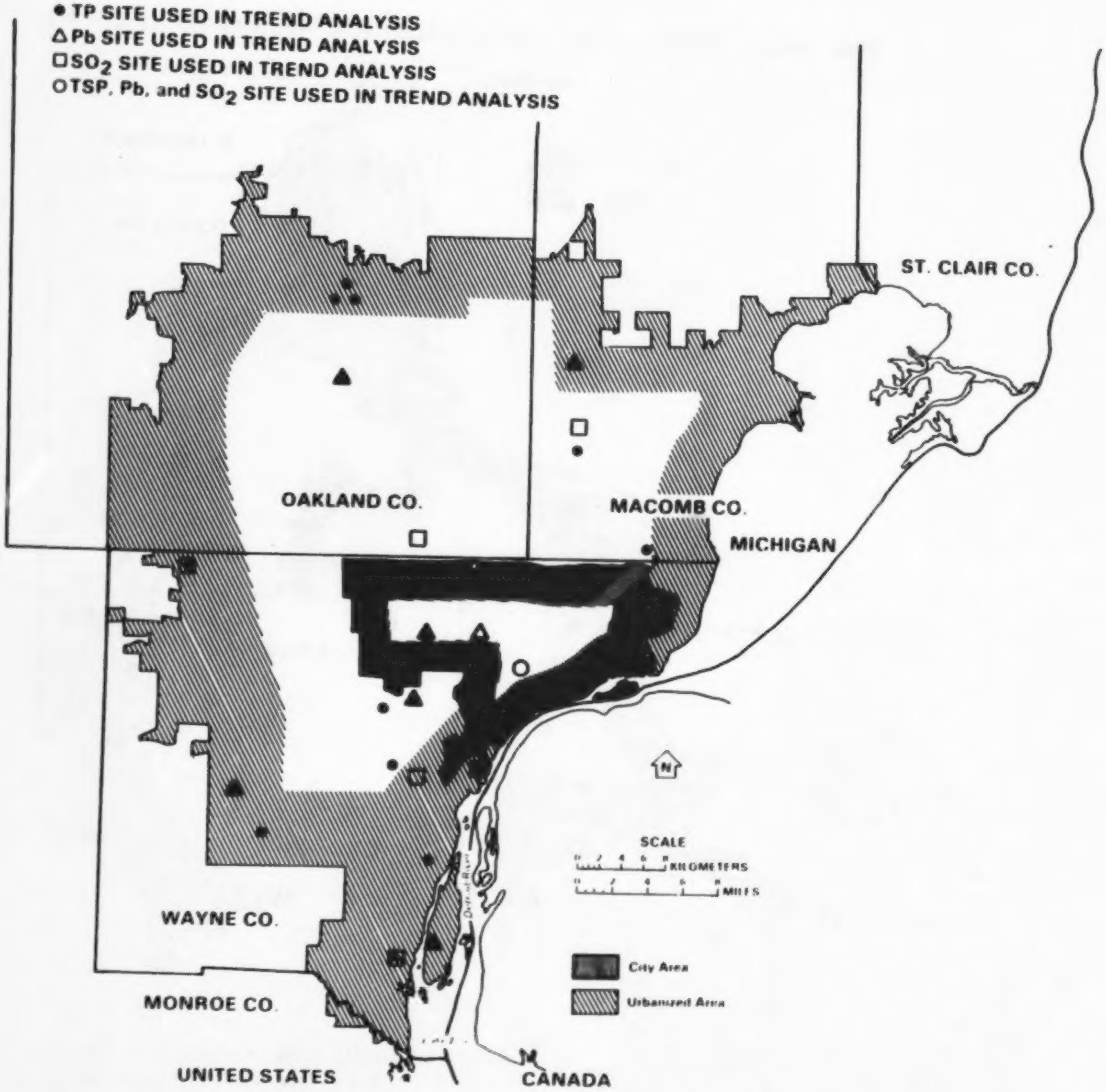

● TP SITE USED IN TREND ANALYSIS
Δ Pb SITE USED IN TREND ANALYSIS
□ SO2 SITE USED IN TREND ANALYSIS
○ TSP, Pb, and SO2 SITE USED IN TREND ANALYSIS
ST. CLAIR CO.
OAKLAND CO.
MACOMB CO.
MICHIGAN
WAYNE CO.
MONROE CO.
UNITED STATES
CANADA
Detroit River
N
SCALE
KILOMETERS
MILES
City Area
Urbanized Area

Figure 5-20 Location of TSP, Pb, and SO_2 Monitoring Sites in Detroit, MI 1981-1985

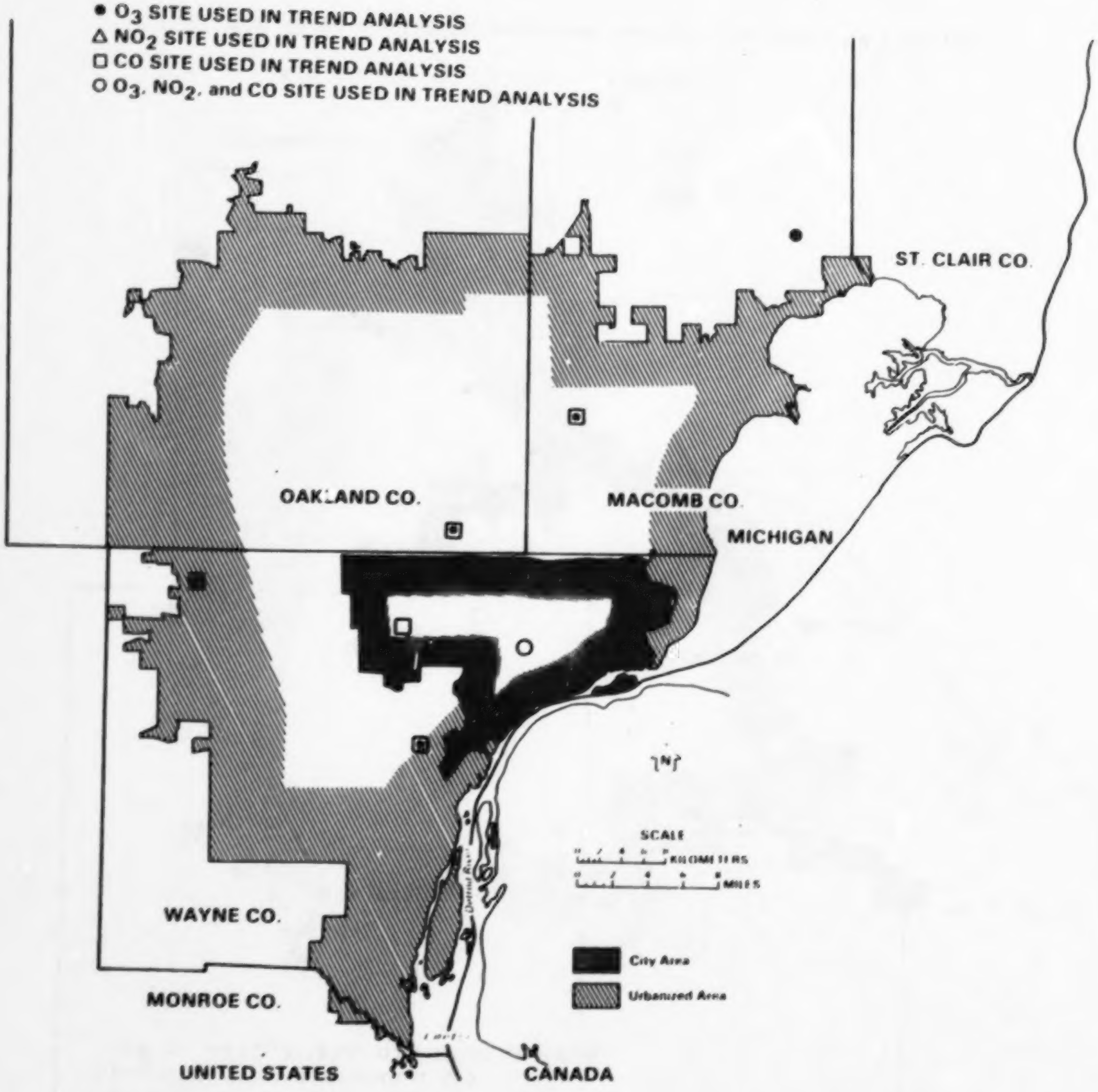

● O_3 SITE USED IN TREND ANALYSIS
△ NO_2 SITE USED IN TREND ANALYSIS
□ CO SITE USED IN TREND ANALYSIS
○ O_3, NO_2, and CO SITE USED IN TREND ANALYSIS
ST. CLAIR CO.
OAKLAND CO.
MACOMB CO.
MICHIGAN
N
SCALE
KILOMETERS
MILES
Detroit River
City Area
Urbanized Area
WAYNE CO.
MONROE CO.
UNITED STATES
CANADA

Figure 5-21. Location of O_3, NO_2, and CO Monitoring Sites in Detroit, MI 1981-1985

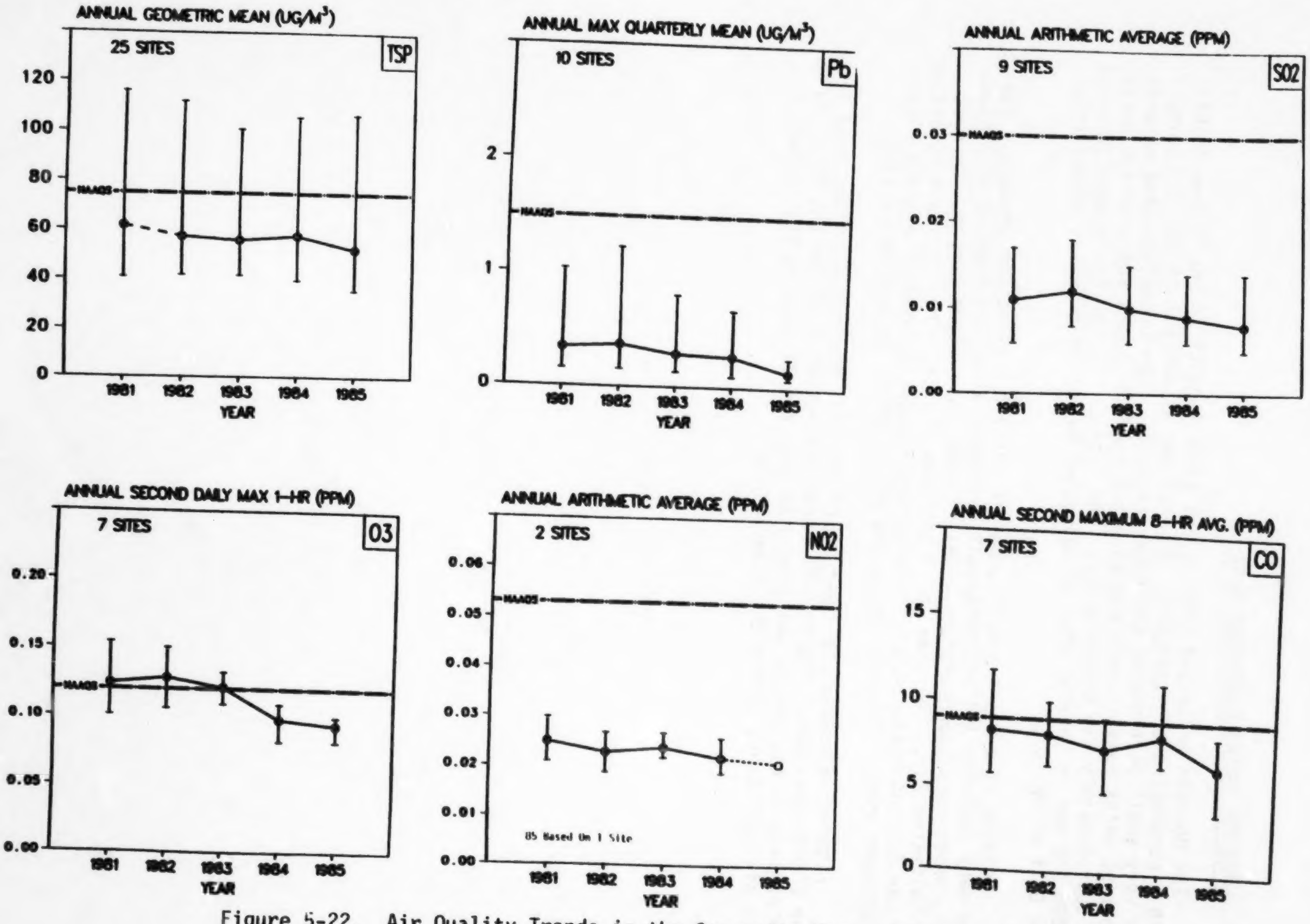


Figure 5-22. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Detroit, MI Urbanized Area, 1981-1985.

5.8 HOUSTON, TEXAS URBANIZED AREA

The Houston urbanized area is the tenth largest in the United States with a population of 2,412,664. It includes almost all of Harris County and very small portions of six other counties. The urbanized area extends about 55 miles east to west and 45 miles north to south and covers a total of approximately 750 square miles. The City of Houston has a population of 1,595,138 and is located west of Galveston Bay about 50 miles inland from the Gulf of Mexico.

Houston is a major seaport, particularly for petroleum products, and it has many refinery and petrochemical complexes along the Houston Ship Channel, which runs approximately 20 miles from the Houston center city east to Galveston Bay. The area is in the Sunbelt, has a mild climate moderated by the Gulf of Mexico, and is one of the fastest growing of all the major urbanized areas. The population has increased 44 percent since 1970.

Figure 5-23 shows the location of the TSP, Pb, and SO_2 sites used in the trends analyses. Figure 5-24 shows the location of the O_3, NO_2, and CO sites used in the trends analyses with Figure 5-25 showing the trends of the six pollutants during the study period.

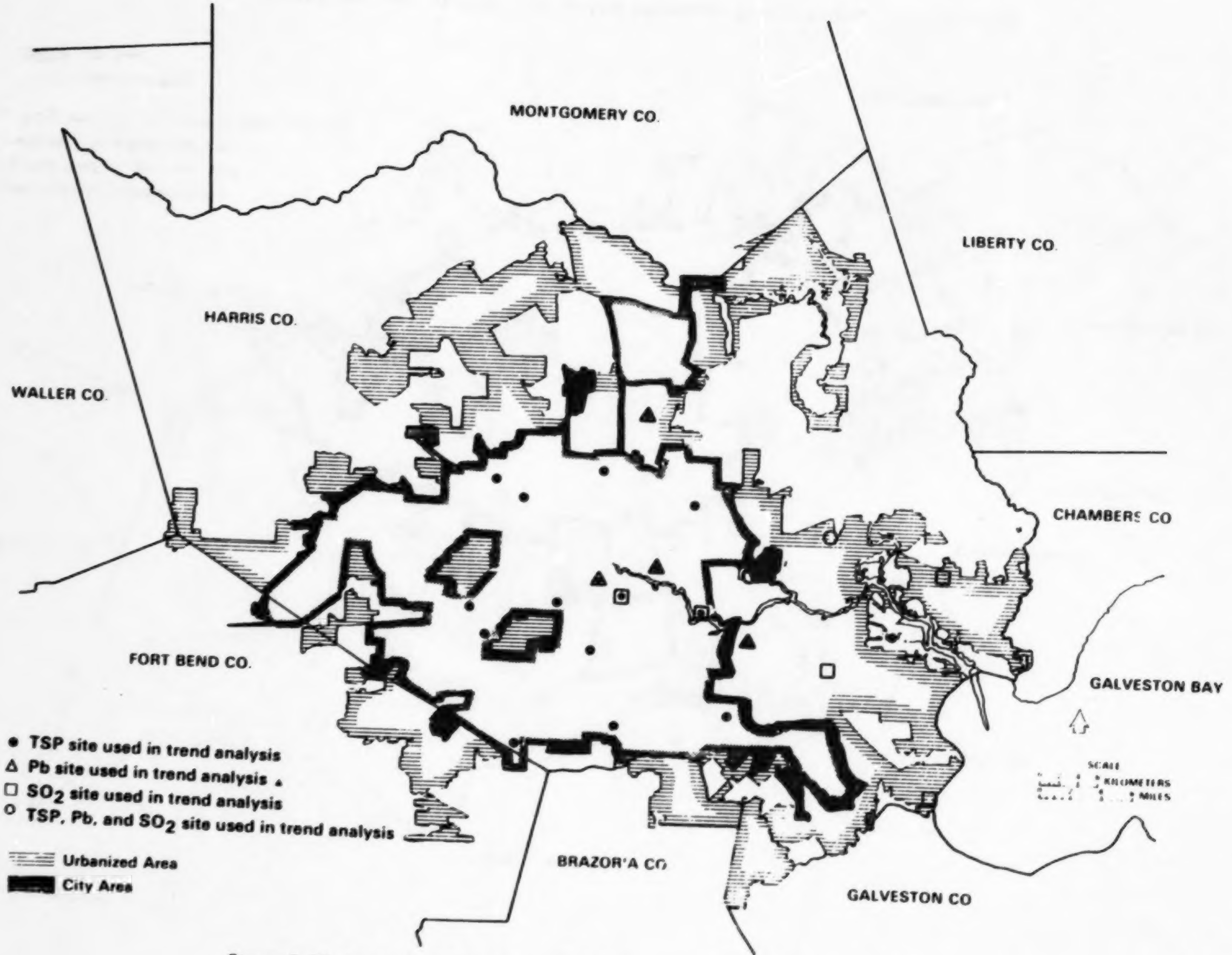

MONTGOMERY CO.
LIBERTY CO.
HARRIS CO.
WALLER CO.
CHAMBERS CO
FORT BEND CO.
GALVESTON BAY
BRAZORIA CO
GALVESTON CO
SCALE
KILOMETERS
MILES
● TSP site used in trend analysis
△ Pb site used in trend analysis
☐ SO2 site used in trend analysis
○ TSP, Pb, and SO2 site used in trend analysis
Urbanized Area
City Area

Figure 5-23 Location of TSP, Pb, and SO_2 Monitoring Sites in Houston, TX 1981 1985

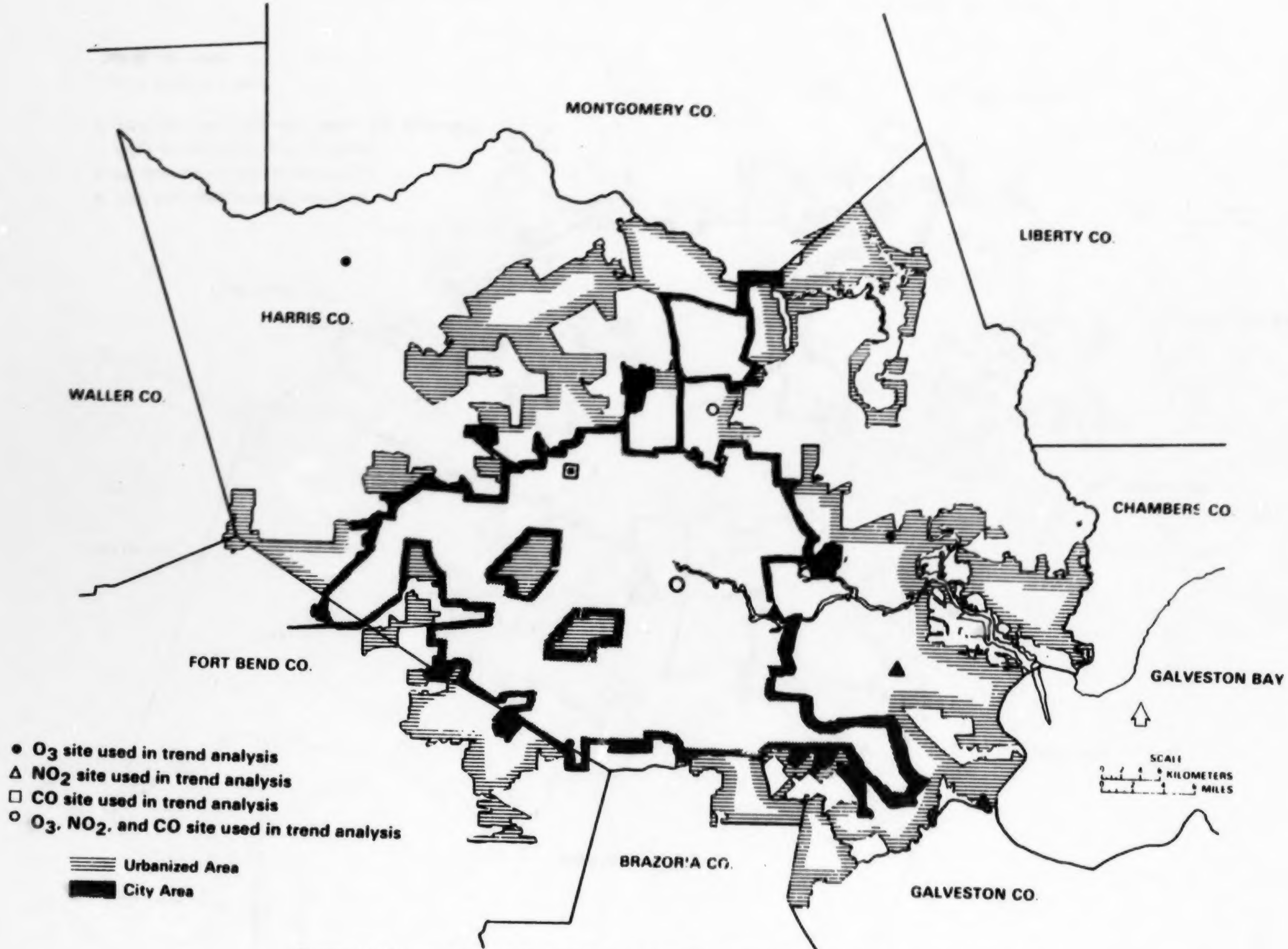

MONTGOMERY CO.
LIBERTY CO.
HARRIS CO.
WALLER CO.
CHAMBERS CO.
FORT BEND CO.
GALVESTON BAY
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
BRAZORIA CO.
GALVESTON CO.
● O_3 site used in trend analysis
Δ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
▤ Urbanized Area
■ City Area

Figure 5-24. Location of O_3, NO_2, and CO Monitoring Sites in Houston, TX 1981-1985

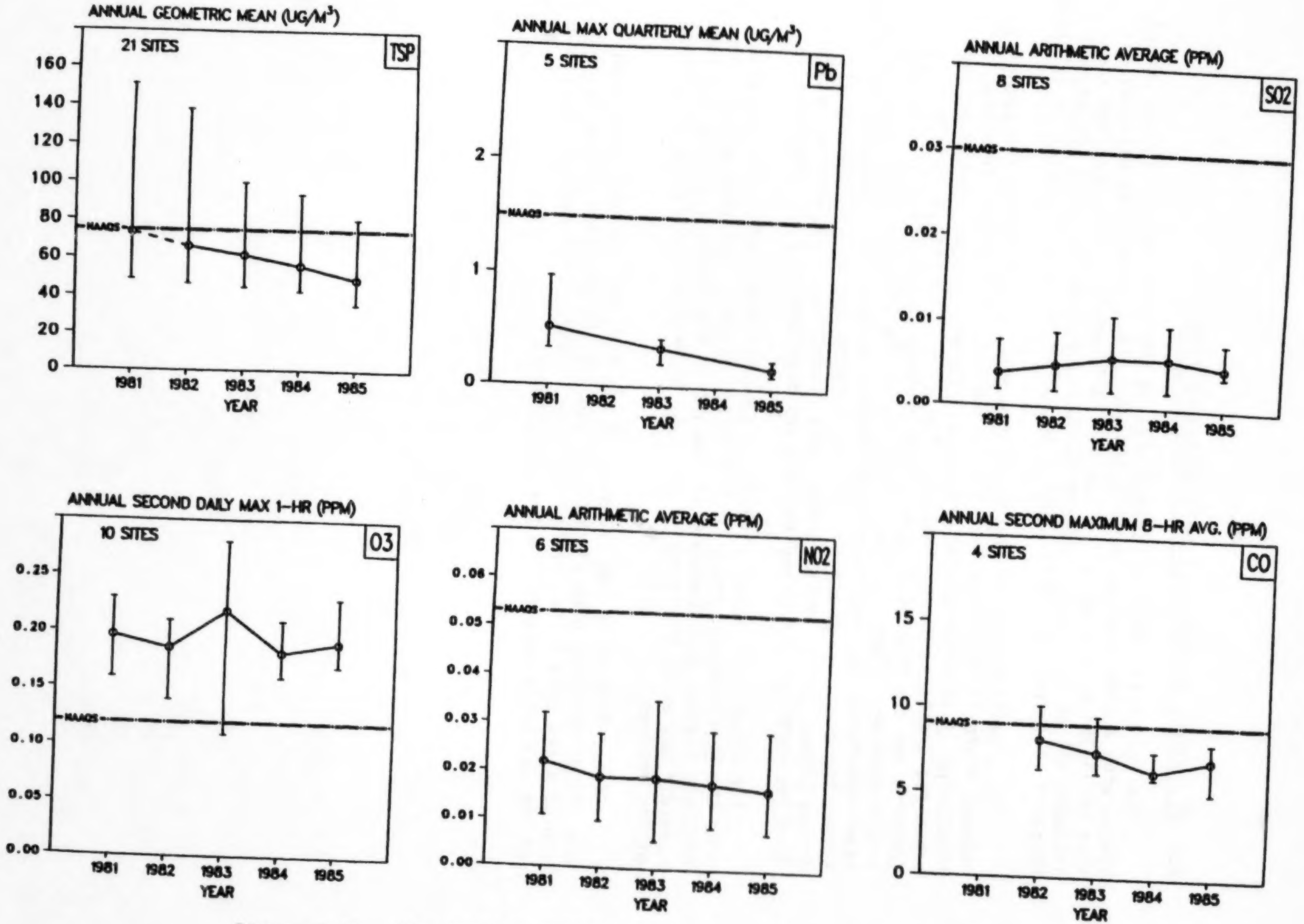


Figure 5-25. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Houston, TX Urbanized Area, 1981-1985.

5.9 ST. LOUIS, MISSOURI-ILLINOIS URBANIZED AREA

The St. Louis, MO-IL urbanized area is the 11th largest in the United States with a 1980 population of 1,848,590. This population reflects a loss of 33,354 or 1.8 percent since the 1970 census. The urbanized area includes all of St. Louis Independent city and parts of three counties in Missouri including St. Louis County, and parts of three counties in Illinois.

The urbanized area is divided by the Mississippi River, the boundary between Missouri and Illinois. The Missouri River branches from the Mississippi just north of the urbanized area and further subdivides the urbanized area's northwest section. The area is centrally located with commerce and the distribution of goods playing an important part in the area's economy. There is heavy industry on the Illinois side, especially steel manufacturing, smelting, and chemical processing. Along the Misissippi River, there are large numbers of fuel burning electric generating plants. At its widest point, the urbanized area extends 48 miles east to west and 32 miles north to south, and encompasses approximately 509 square miles.

The areas continental climate is somewhat modified by its location near the geographical center of the United States. The area enjoys four distinct seasons with the cold air masses to the North in Canada and the warm air masses to the South in the Gulf of Mexico alternating in control of the weather.

Figure 5-26 shows the location of the TSP, Pb, and SO_2 sites used in the trends analyses with Figure 5-27 showing the location of the O_3, NO_2, and CO sites used in the trends analyses. Figure 5-28 depicts the trends of the six pollutants during the study period.

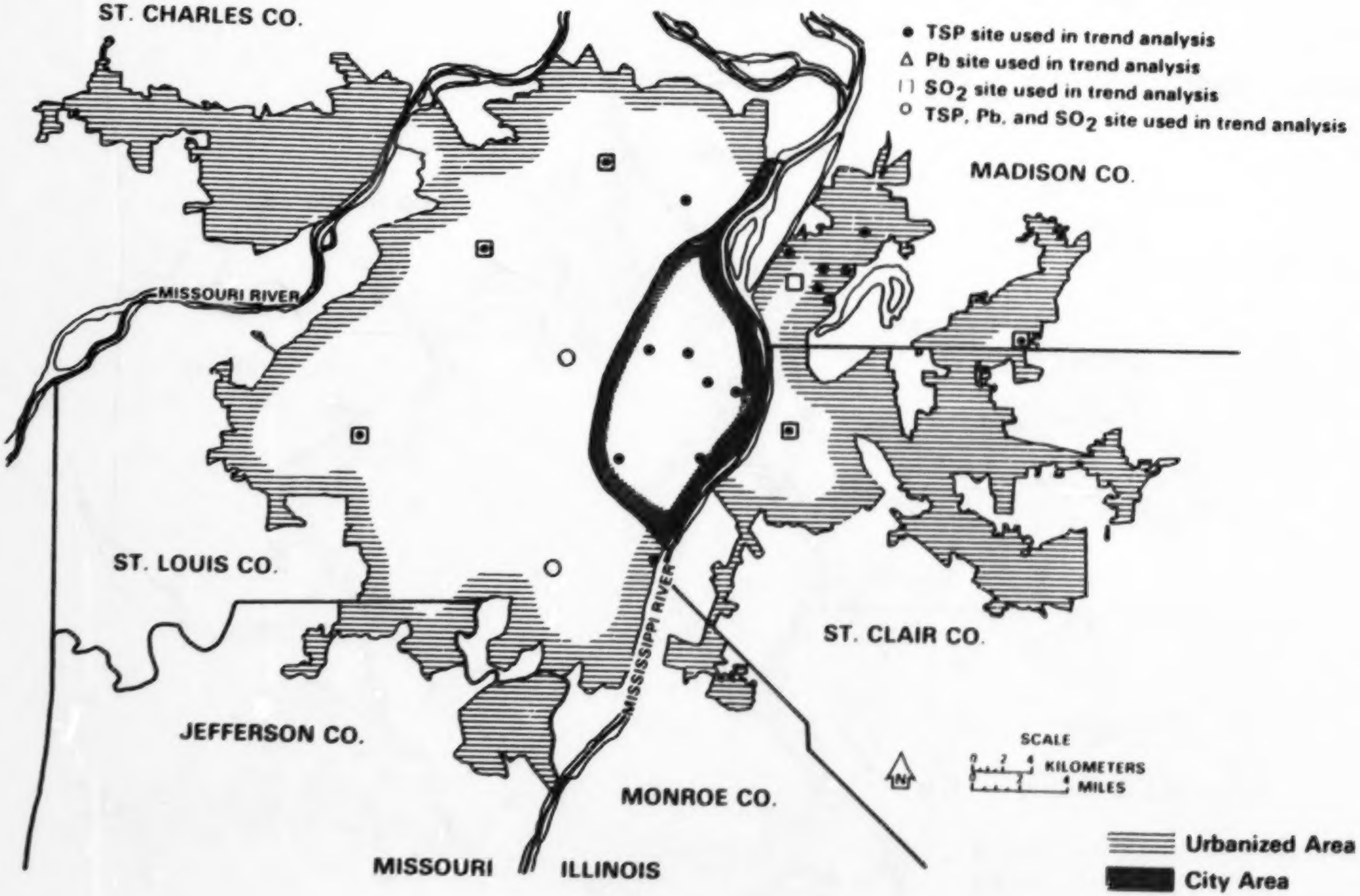

ST. CHARLES CO.
● TSP site used in trend analysis
Δ Pb site used in trend analysis
□ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
MADISON CO.
MISSOURI RIVER
ST. LOUIS CO.
MISSISSIPPI RIVER
ST. CLAIR CO.
JEFFERSON CO.
SCALE
0 2 4 KILOMETERS
0 2 4 MILES
N
MONROE CO.
MISSOURI
ILLINOIS
Urbanized Area
City Area

Figure 5-26 Location of TSP, Pb, and SO_2 Monitoring Sites in St. Louis, MO IL 1981 1985

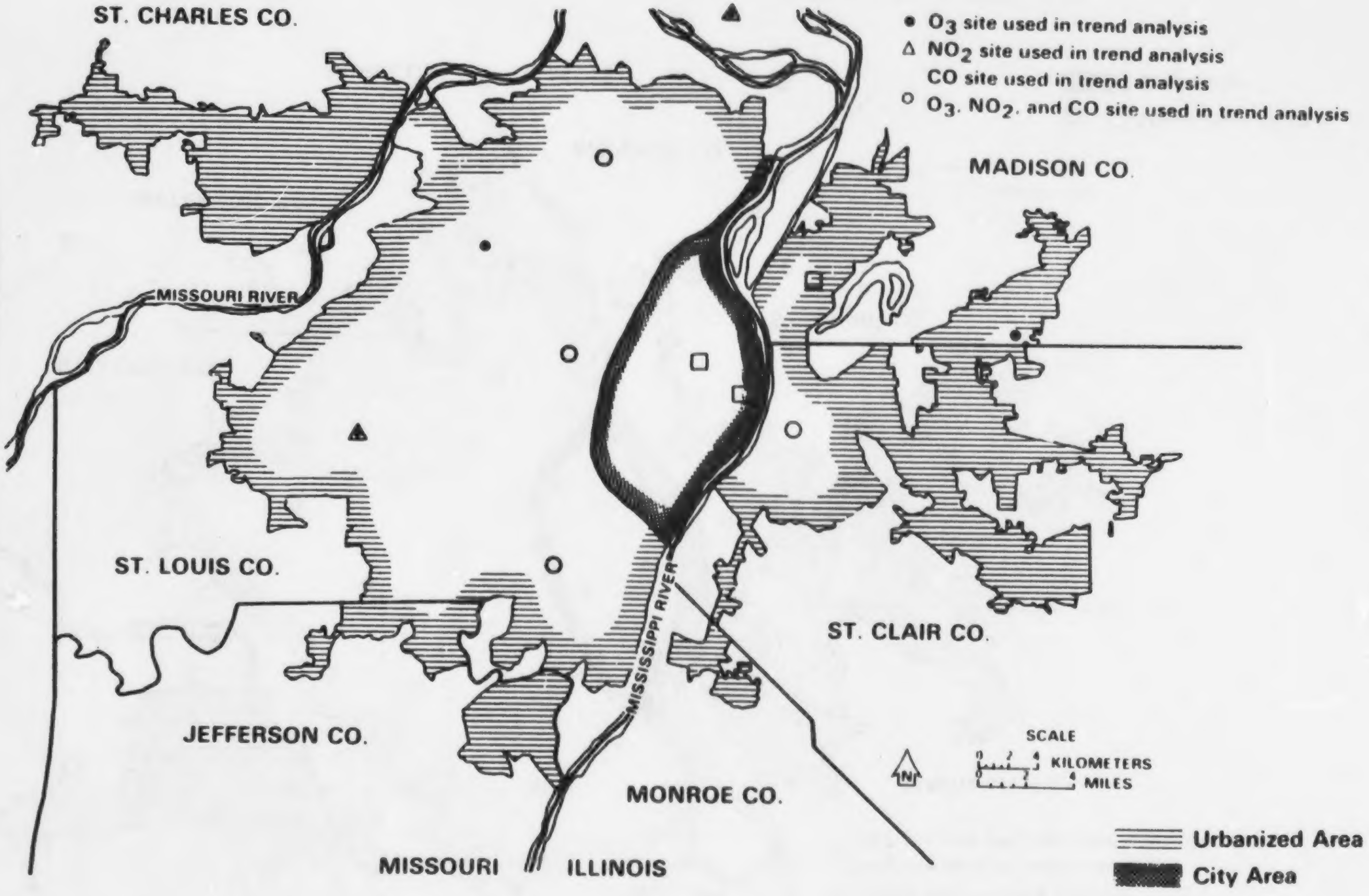

ST. CHARLES CO.
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
MADISON CO.
MISSOURI RIVER
ST. LOUIS CO.
MISSISSIPPI RIVER
ST. CLAIR CO.
JEFFERSON CO.
SCALE
0 2 4 KILOMETERS
0 2 4 MILES
N
MONROE CO.
MISSOURI
ILLINOIS
Urbanized Area
City Area

Figure 5 27 Location of O_3, NO_2, and CO Monitoring Sites in St Louis, MO IL 1981 1985

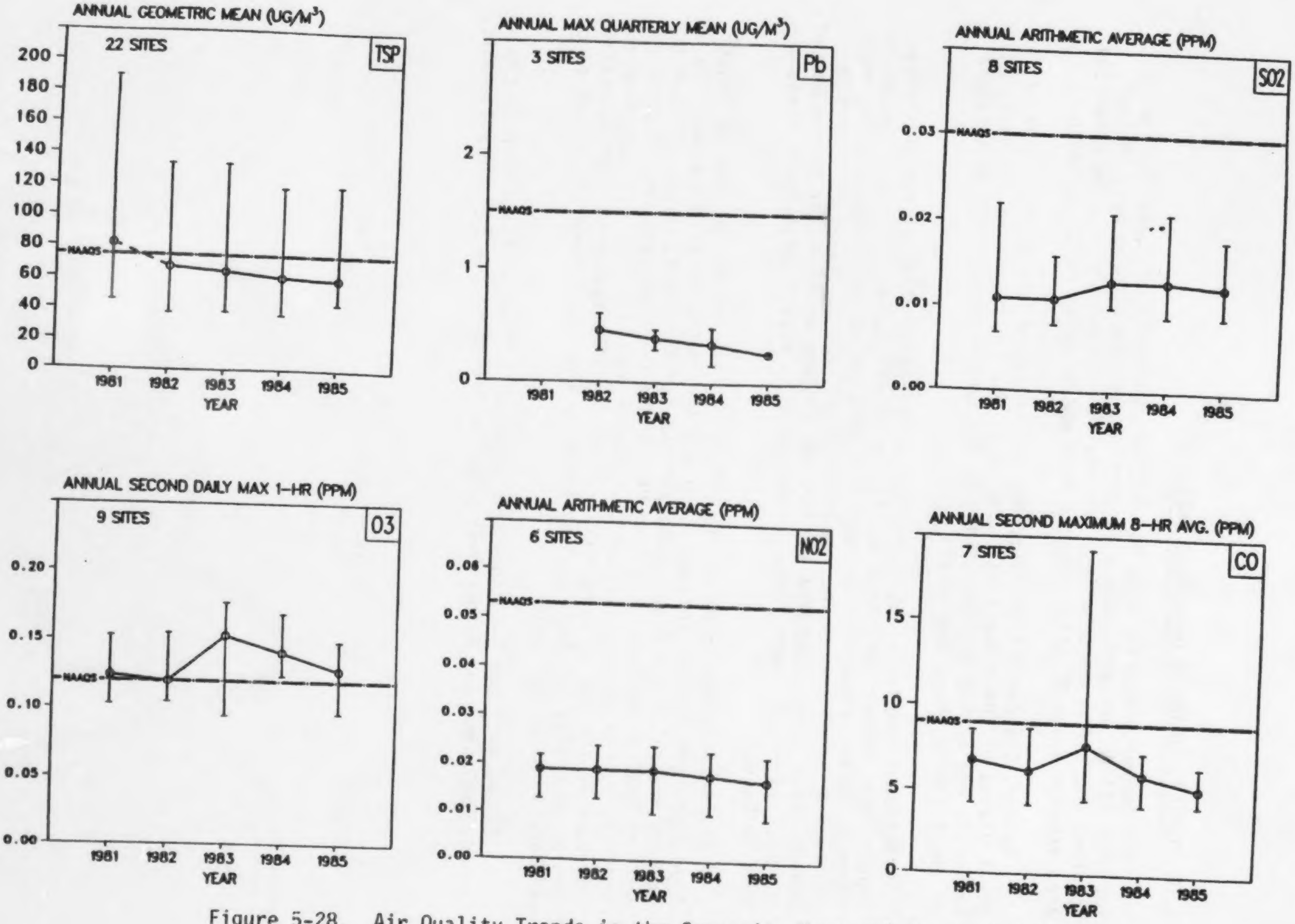


Figure 5-28. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the St. Louis, MO-IL Urbanized Area, 1981-1985.

5.10 DENVER, COLORADO URBANIZED AREA

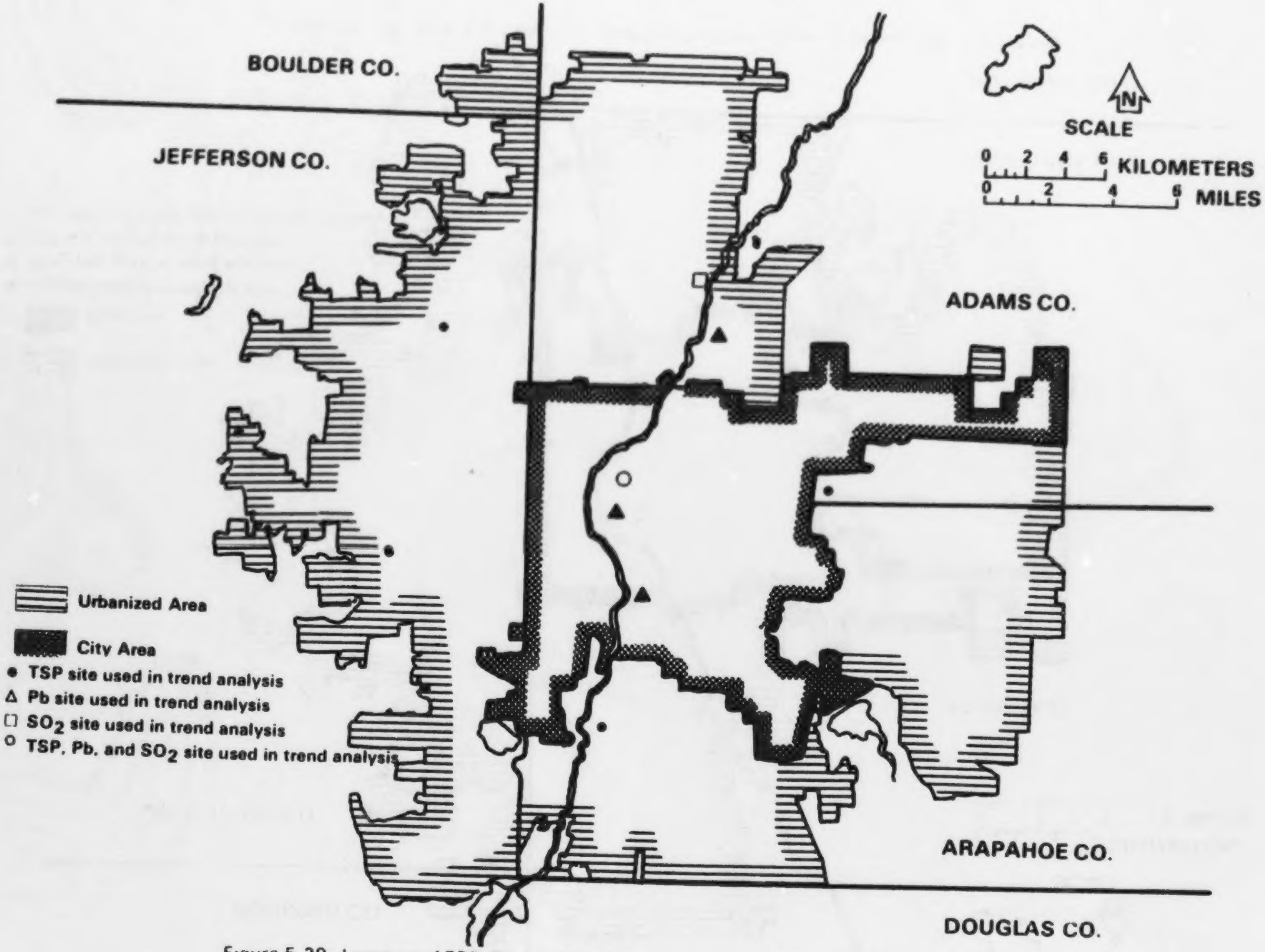
The Denver urbanized area had a 1980 population of 1,352,070 and includes all of Denver County plus portions of Adams, Arapahoe, Boulder, Douglas, and Jefferson Counties. At the maximum boundaries, the urbanized area extends about 27 miles east to west and 26 miles north to south.

Denver, the capital of Colorado, is located at the western edge of the great plains of the Midwest with the Rocky Mountains just to its west. Denver is one of the highest cities in the United States with an altitude of about 1 mile above sea level.

Although manufacturing is minimal compared to other cities of similar populations, Denver does have manufacturing industries for rubber goods and luggage. Other industries include food processing, milling, printing and publishing, steel processing, machinery manufacture, and power generation. Denver has a large stockyard and has the largest sheep market in the United States. In recent years, many energy concerns have located their headquarters in Denver.

The meteorology in Denver is unique in that air masses from at least four different sources influence the weather in the urbanized area. These sources are polar air from Canada and the far Northwest, moist air from the Gulf of Mexico, warm dry air from Mexico and the Southwest, and Pacific air modified by the passage overland. Since Denver is a long distance from any moisture source and is separated from the Pacific source by high mountains, Denver generally has low relative humidity and low average precipitation of around 14 inches per year.

Figure 5-29 and 5-30 show the locations of the monitors used in the trends analyses, and Figure 5-31 show the trends graphs for the pollutants.



BOULDER CO.
JEFFERSON CO.
ADAMS CO.
ARAPAHOE CO.
DOUGLAS CO.
N
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
Urbanized Area
City Area
● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO2 site used in trend analysis
○ TSP, Pb, and SO2 site used in trend analysis

Figure 5-29. Location of TSP, Pb, and SO_2 Monitoring Sites in Denver, CO 1981-1985

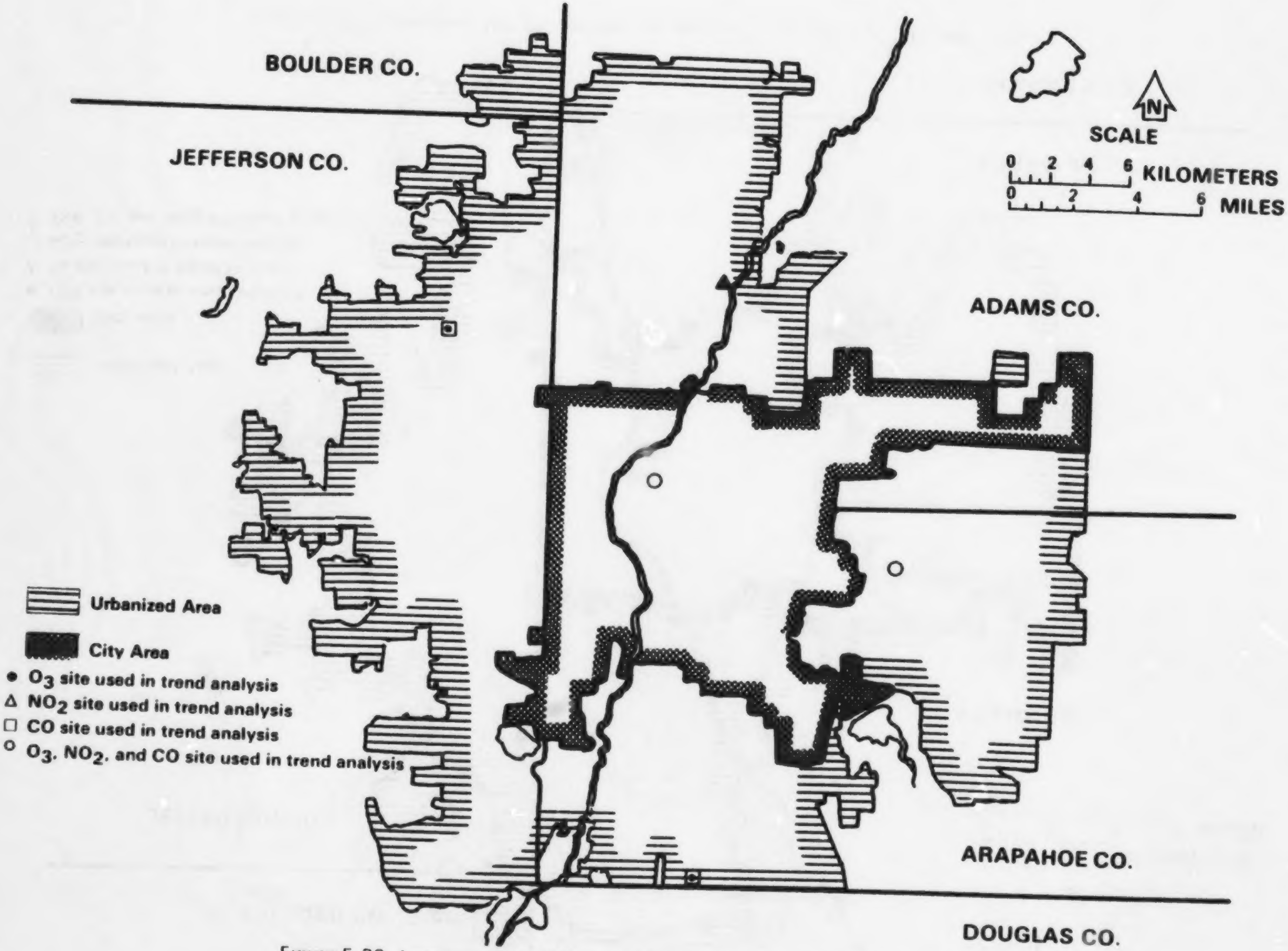

BOULDER CO.
JEFFERSON CO.
ADAMS CO.
ARAPAHOE CO.
DOUGLAS CO.
N
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
Urbanized Area
City Area
● O_3 site used in trend analysis
Δ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis

Figure 5-30 Location of O_3, NO_2, and CO Monitoring Sites in Denver, CO 1981-1985

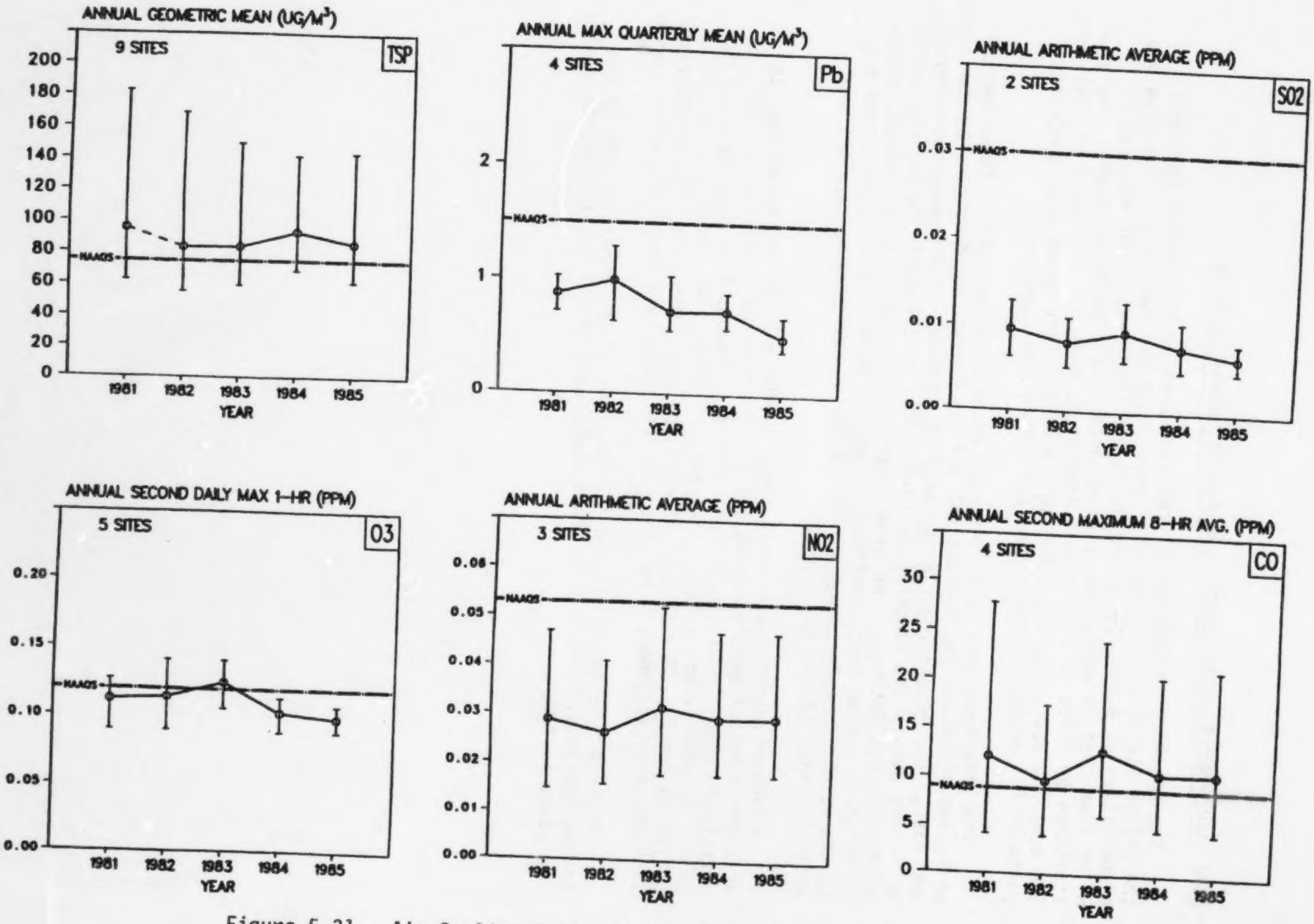


Figure 5-31. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Denver, CO Urbanized Area, 1981-1985.

5.11 LOS ANGELES-LONG BEACH, CALIFORNIA URBANIZED AREA

The Los Angeles-Long Beach urbanized area is the second largest in the United States both in terms of population and land area. The area has a population of 9,479,436 according to the 1980 census and measures 70 miles from east to west, and 71 miles across from north to south. The area stretches 90 miles in its longest dimension, that is, northwest to southeast and contains approximately 1,700 square miles. The urban area comprises parts of Los Angeles, Orange, and San Bernardino Counties.

The urbanized area is a flat area bounded by the Pacific Ocean on the west, and south and the San Gabriel and San Bernardino Mountains on the north and east. The meteorology in the area is complex, with frequent occurrences of strong persistent temperature inversions, particularly during the period of May through October. The wind pattern is dominated by a land-sea breeze circulation system that sometimes allows pollutants to be transported out to sea at night, only to return inland during the ensuing daylight hours with the onset of the sea breeze.

Although automotive sources comprise the bulk of the emissions, the area has a lot of manufacturing and service related industries as well as petroleum refining and production, chemical plants, fuel burning electric utilities, and numerous industrial boilers which also contribute to the pollution levels. The climate is mild and along with the high incidence of sunlight and latitude of the area, is conducive to a year-long ozone season.

Figures 5-32 and 5-33 show the location of the monitors used in the trends analyses. Figure 5-34 shows the trends of the six pollutants during the study period.

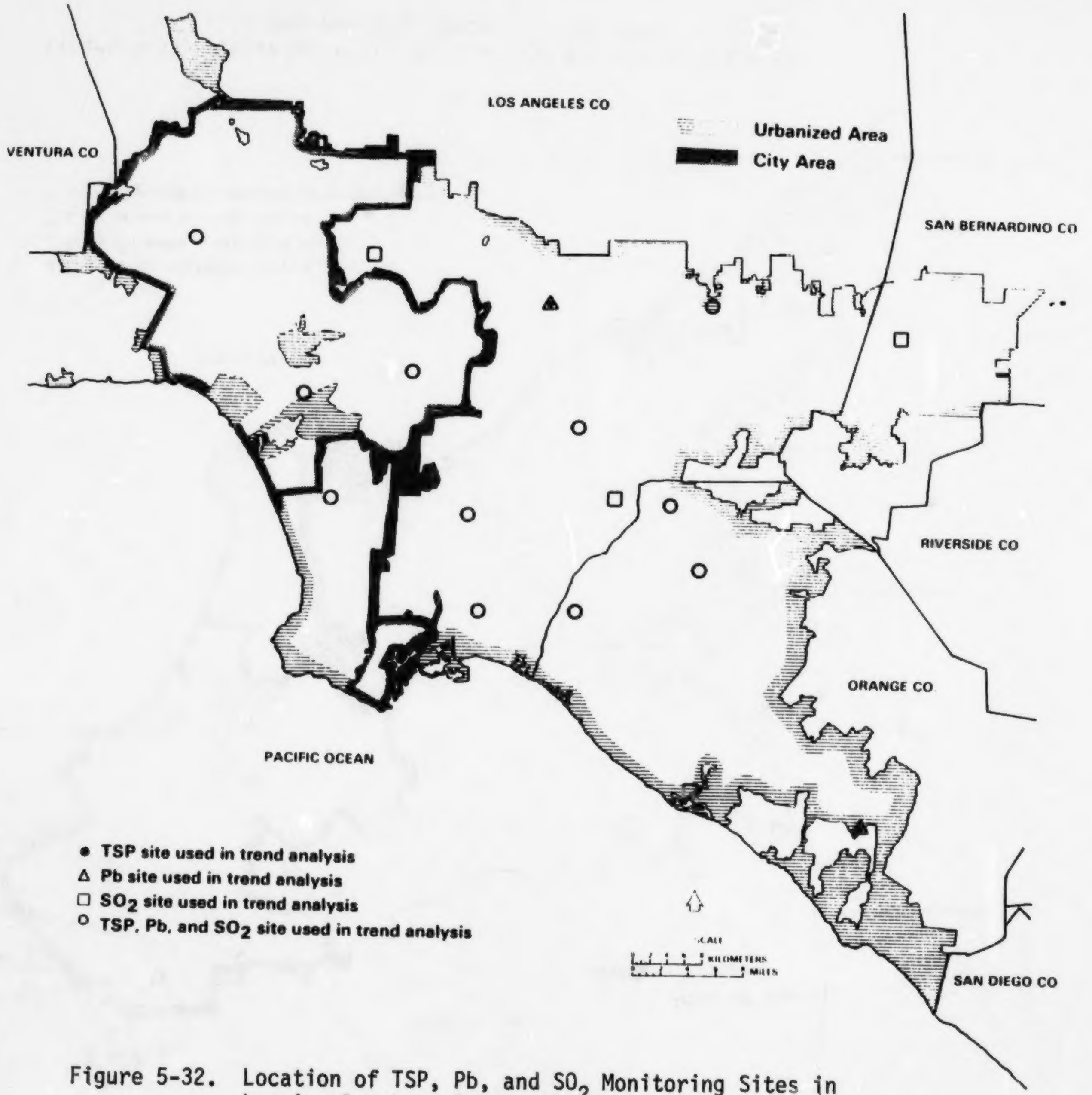

LOS ANGELES CO
Urbanized Area
City Area
VENTURA CO
SAN BERNARDINO CO
RIVERSIDE CO
ORANGE CO
PACIFIC OCEAN
SAN DIEGO CO
● TSP site used in trend analysis
Δ Pb site used in trend analysis
□ SO2 site used in trend analysis
○ TSP, Pb, and SO2 site used in trend analysis
SCALE
KILOMETERS
MILES

Figure 5-32. Location of TSP, Pb, and SO_2 Monitoring Sites in Los Angeles-Long Beach, CA 1981 - 1985.

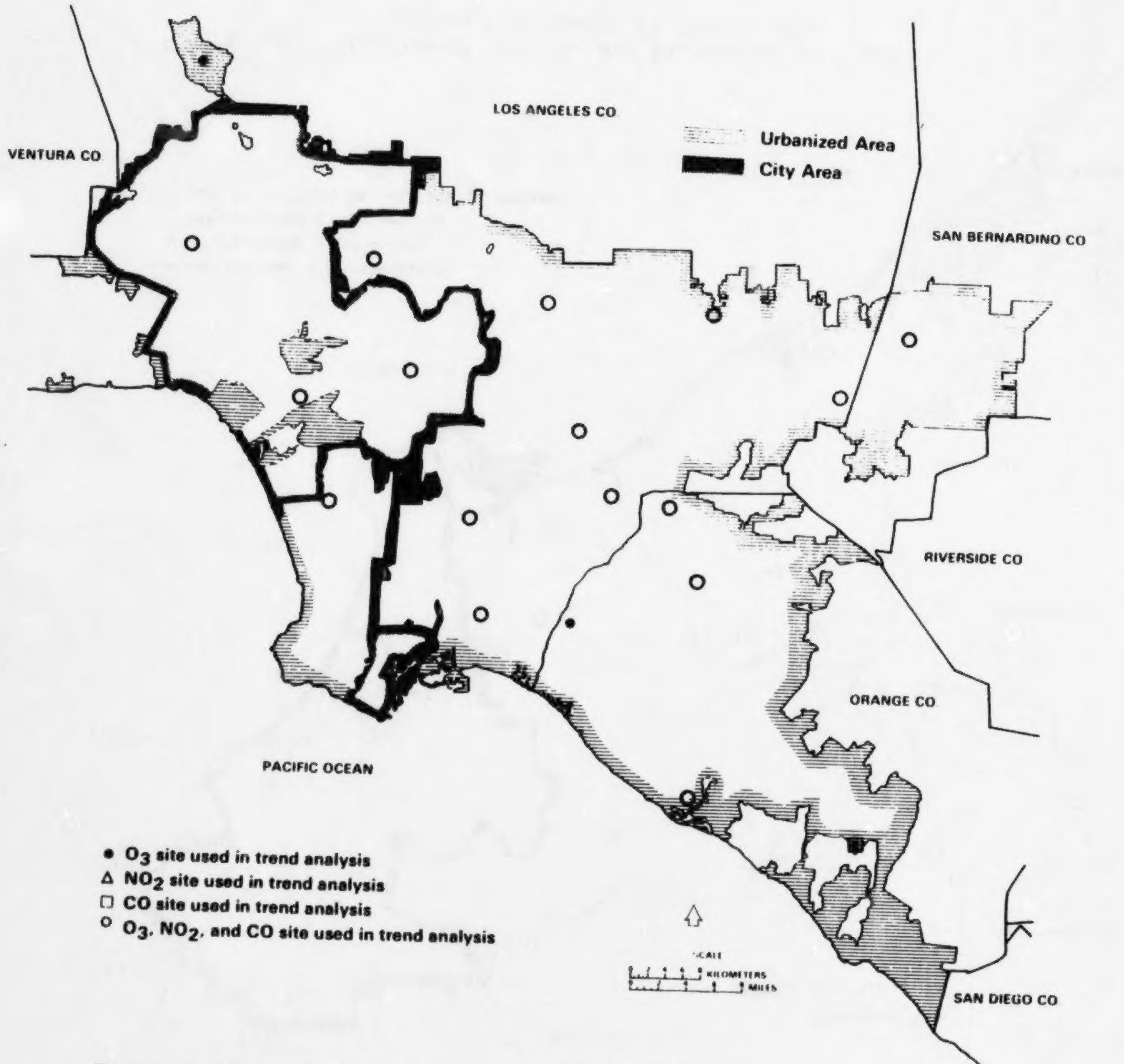

LOS ANGELES CO
Urbanized Area
City Area
VENTURA CO
SAN BERNARDINO CO
RIVERSIDE CO
ORANGE CO
PACIFIC OCEAN
SAN DIEGO CO
● O_3 site used in trend analysis
Δ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
SCALE
KILOMETERS
MILES

Figure 5-33. Location of O_3, NO_2, and CO Monitoring Sites in Los Angeles-Long Beach, CA 1981-1985.

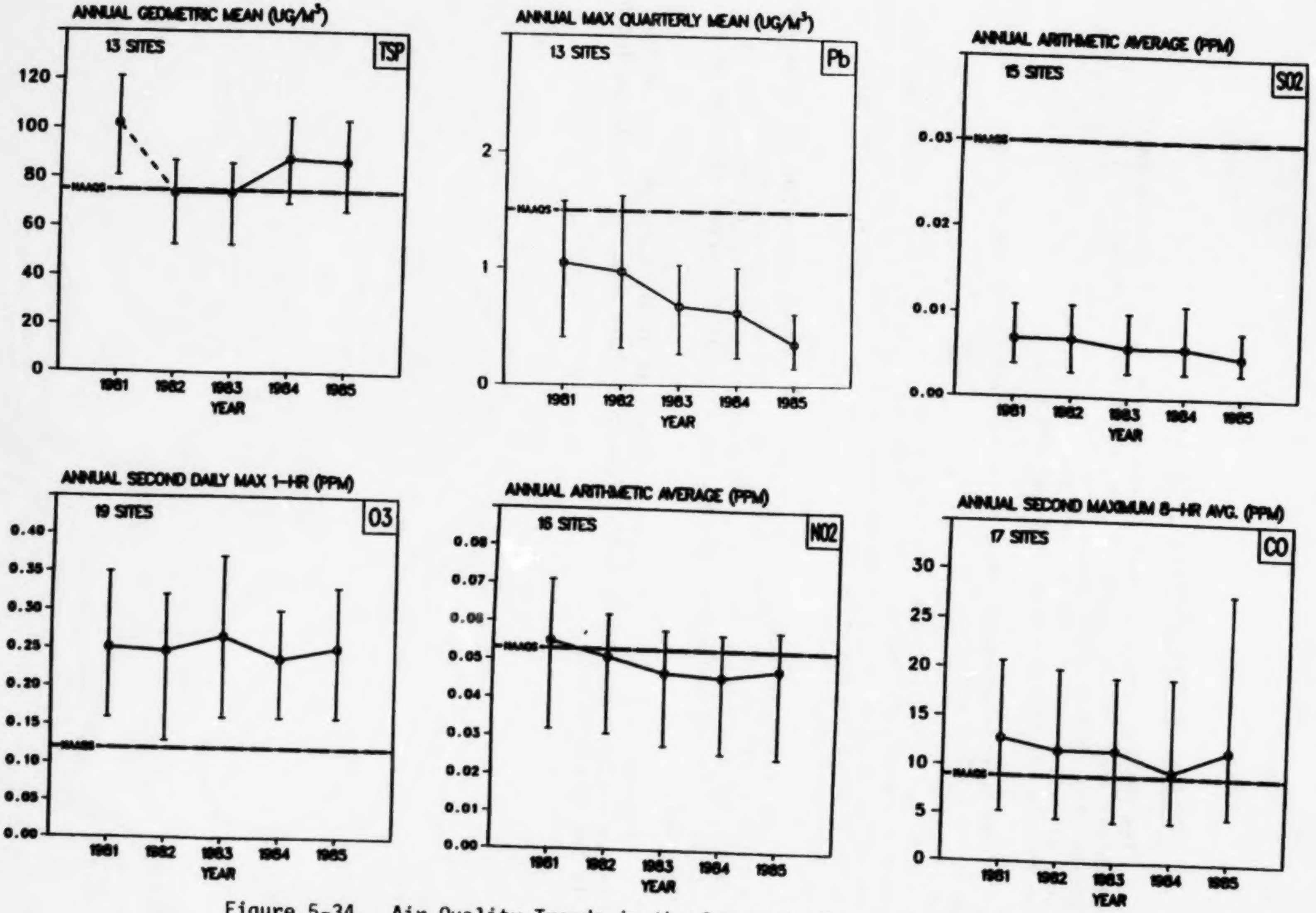


Figure 5-34, Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Los Angeles - Long Beach, CA Urbanized Area. 1981-1985.

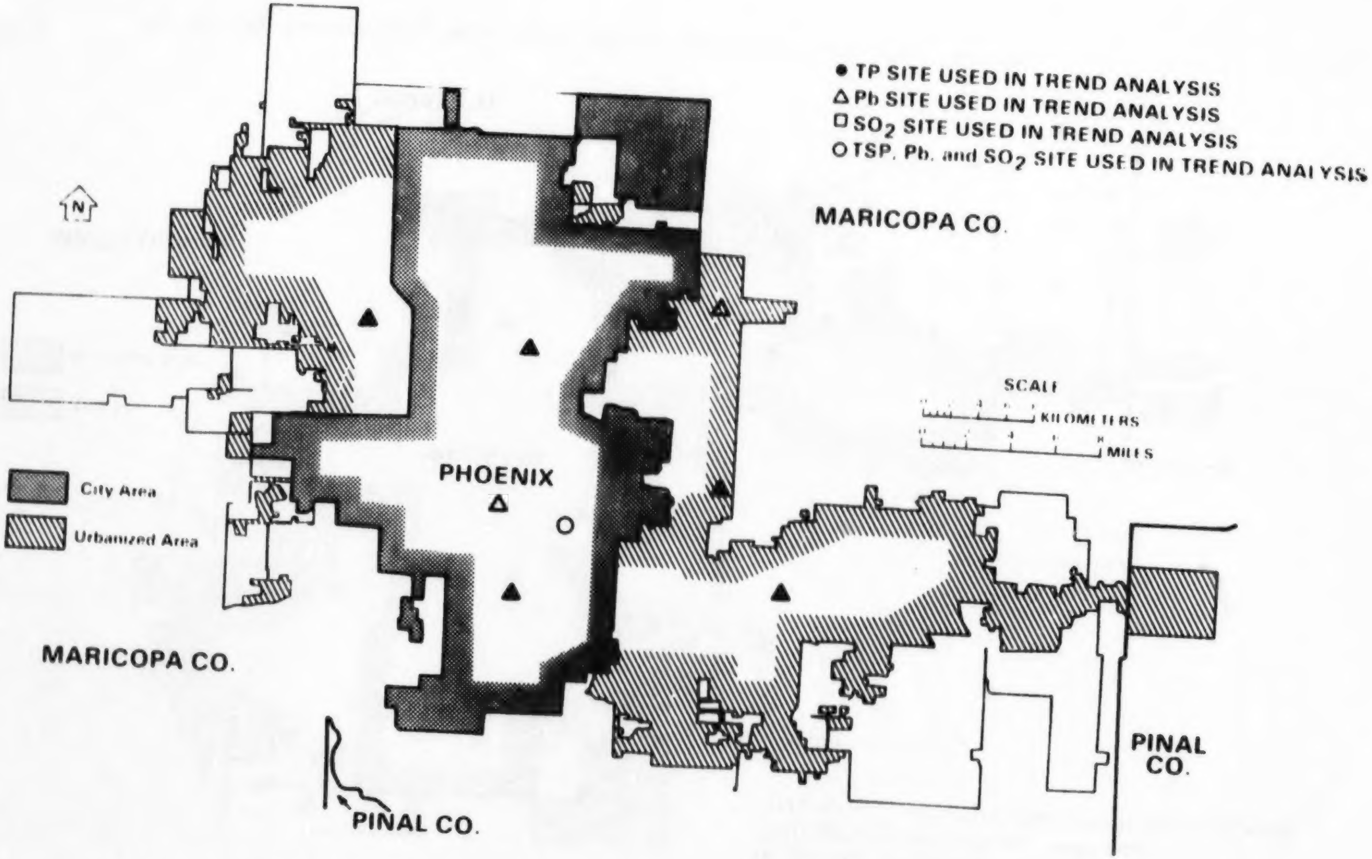
5.12 PHOENIX, ARIZONA URBANIZED AREA

The Phoenix urbanized area is one of the fastest growing major urbanized areas in the country. The population increased by 65 percent between the 1970 and 1980 census from 863,357 to 1,409,442. The urbanized area extends 51 miles east to west and 32 miles north to south. The city of Phoenix itself has a population of 789,704.

The Phoenix urbanized area is in the Sunbelt and has moderate to warm winters and hot summers. The "Valley of the Sun" as the area is called averages sunshine 86 percent of all the possible sunshine hours with only 7 inches of rain per year. Mountainous terrain is located to the north, east and south of Phoenix. The differential cooling of the desert and the mountains coupled with a nightime drainage wind flow pattern causes pollutants to be transported away from Phoenix during the day only to return later during the night.

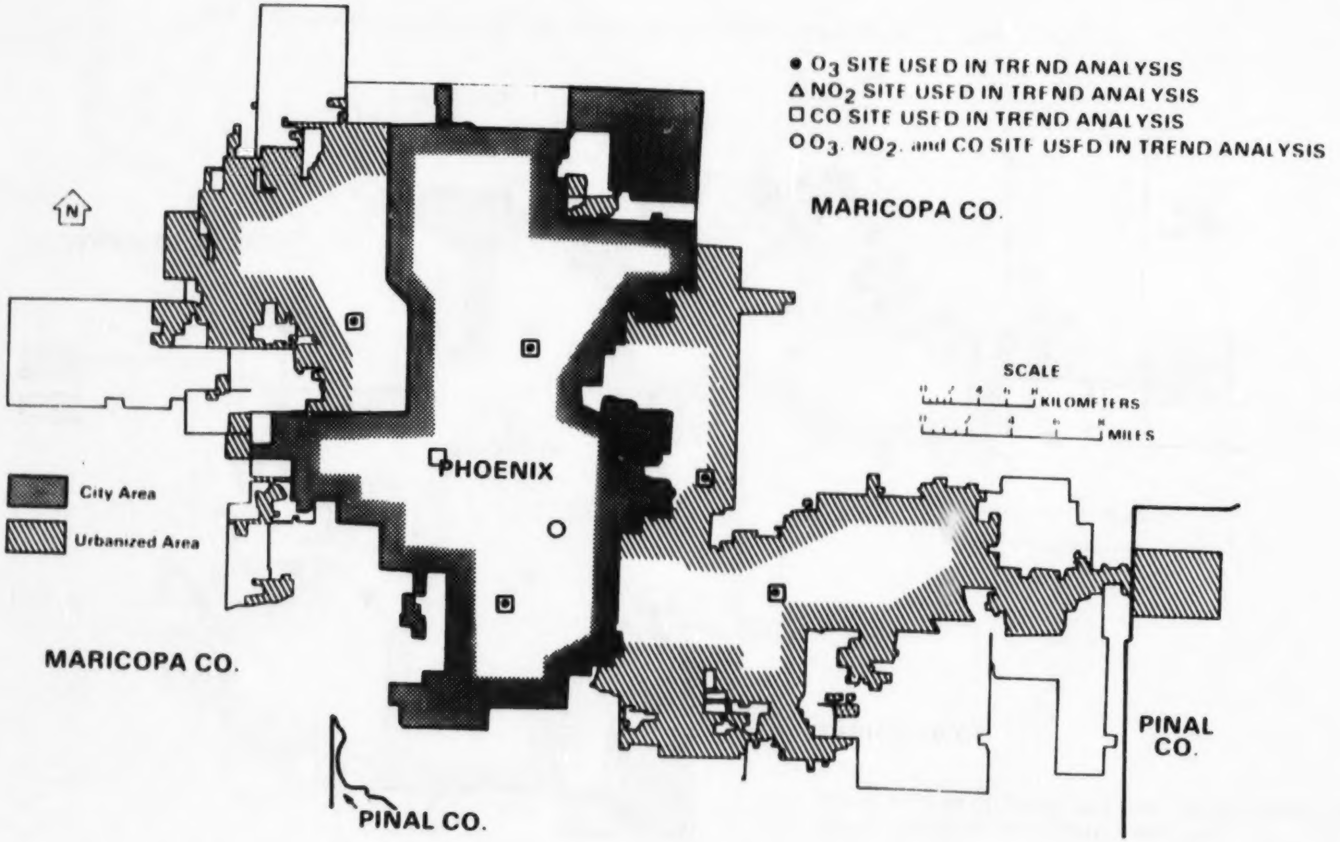
The "Valley of the Sun" is primarily a tourist area with approximately 6 million visitors annually. Accordingly, the economy is primarily commercial and service oriented. Although tourism is high, among the 75 largest metropolitan areas, Phoenix has the smallest number of miles of freeways.

Figures 5-35 and 5-36 show the locations of the monitors used in the trends analyses and Figure 5-37 illustrates the trends for all the pollutants in the urbanized area.



● TP SITE USED IN TREND ANALYSIS
△ Pb SITE USED IN TREND ANALYSIS
□ SO2 SITE USED IN TREND ANALYSIS
○ TSP, Pb, and SO2 SITE USED IN TREND ANALYSIS
MARICOPA CO.
SCALE
KILOMETERS
MILES
PHOENIX
City Area
Urbanized Area
MARICOPA CO.
PINAL CO.
PINAL CO.
N

Figure 5 35 Location of TSP, Pb, and SO_2 Monitoring Sites in Phoenix, AZ 1981 1985



● O_3 SITE USED IN TREND ANALYSIS
△ NO_2 SITE USED IN TREND ANALYSIS
☐ CO SITE USED IN TREND ANALYSIS
○ O_3, NO_2, and CO SITE USED IN TREND ANALYSIS
MARICOPA CO.
N
SCALE
0 2 4 6 8 KILOMETERS
0 2 4 6 8 MILES
PHOENIX
City Area
Urbanized Area
MARICOPA CO.
PINAL CO.
PINAL CO.

Figure 5 36 Location of O_3, NO_2, and CO Monitoring Sites in Phoenix, AZ 1981 1985

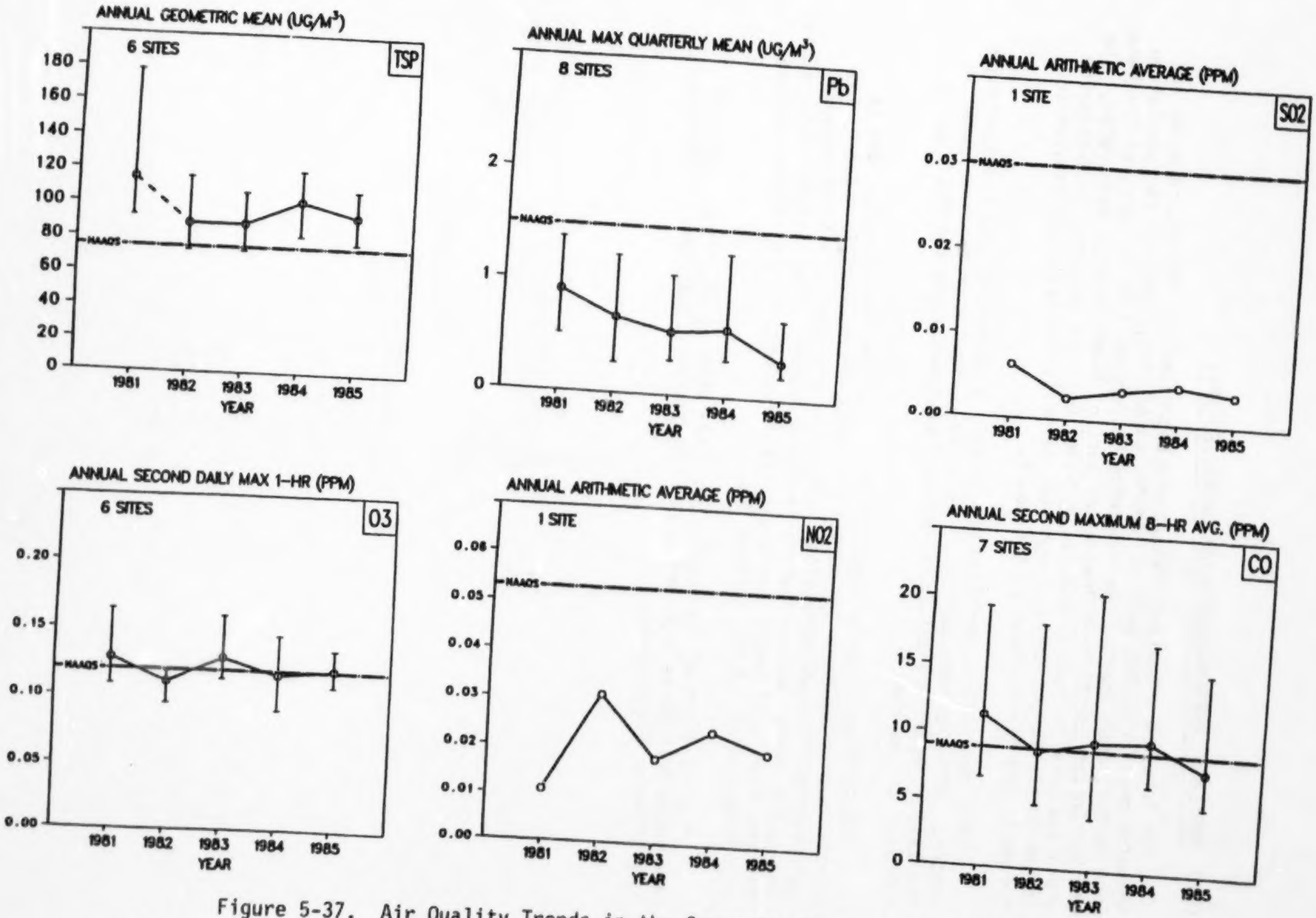


Figure 5-37. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Phoenix, AZ Urbanized Area, 1981-1985.

5.13 PORTLAND, OREGON-WASHINGTON URBANIZED AREA

The Portland urbanized area covers approximately 300 square miles and includes over 1,020,000 people. Approximately 50 percent of the population live in Multnomah County, the remaining 50 percent live in parts of Clackamas and Washington Counties in Oregon and part of Clark County, Washington. The urbanized area is roughly bounded by Hazel Dell and Orchards in Washington to the north; Forest Grove, Oregon to the west; Troutdale and Gresham to the east; and Beaver Creek to the south.

Until the 1940's, Portland was largely a commercial and transportation center. With the introduction of relatively cheap hydroelectric power in the 1940's, metallurgical and chemical industries augmented the ongoing commerce of the area.

The Portland area is about 65 miles from the Pacific Ocean and is partially shielded from the maritime climate of the Pacific Ocean by the surrounding hills and mountains. The winds are generally southeasterly during the winter and northwesterly during summer. The average precipitation for the area is 37 inches and typically 88 percent of the rainfall occurs in the months of October through May.

The locations of the monitoring sites used in the trends analyses are shown in Figures 5-38 and 5-39. The trends graphs for all pollutants are shown in Figure 5-40.

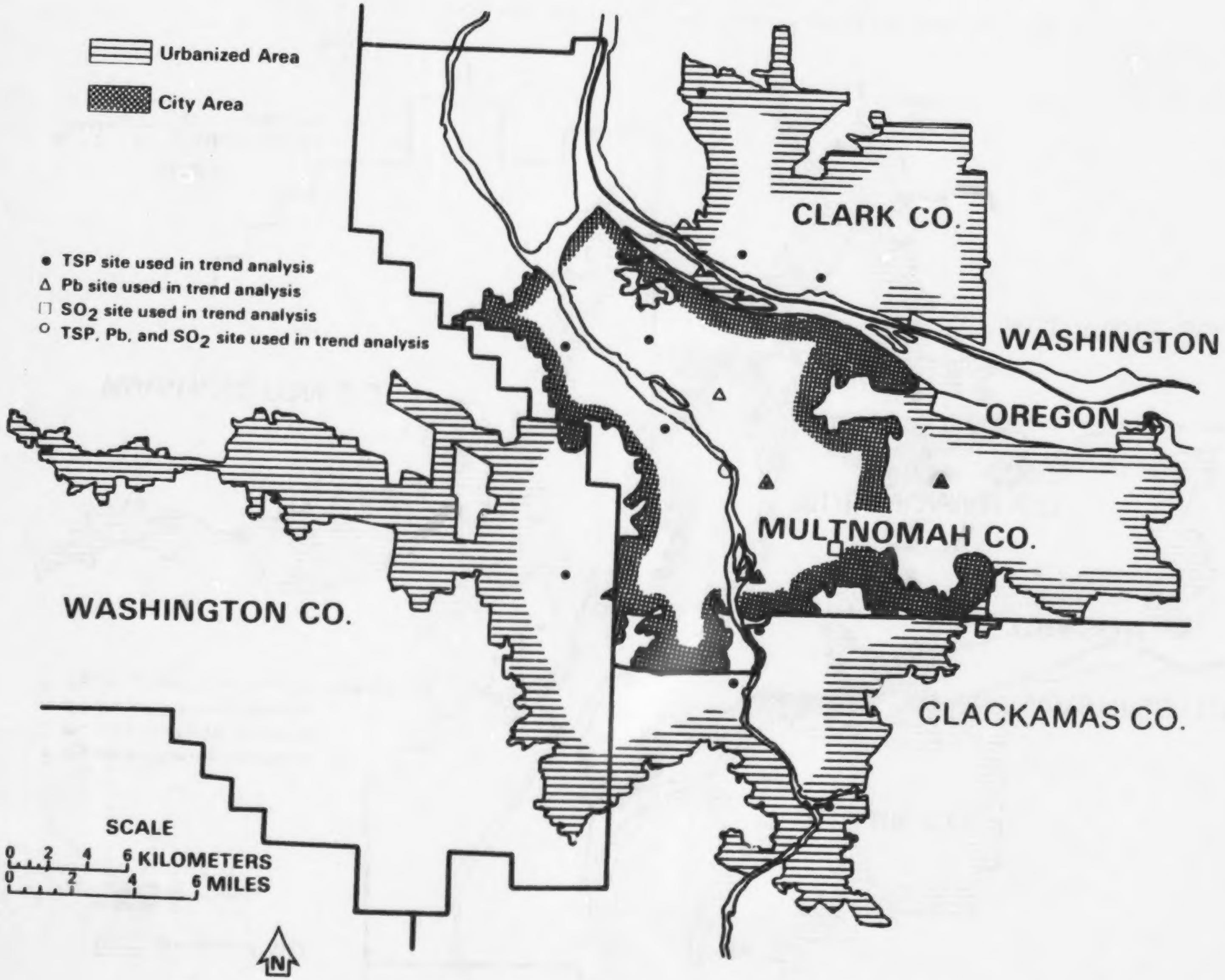

Urbanized Area
City Area
● TSP site used in trend analysis
Δ Pb site used in trend analysis
□ SO2 site used in trend analysis
○ TSP, Pb, and SO2 site used in trend analysis
CLARK CO.
WASHINGTON
OREGON
MULTNOMAH CO.
WASHINGTON CO.
CLACKAMAS CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
N

Figure 5-38. Location of TSP, Pb, and SO_2 Monitoring Sites in Portland, OR - WA 1981-1985

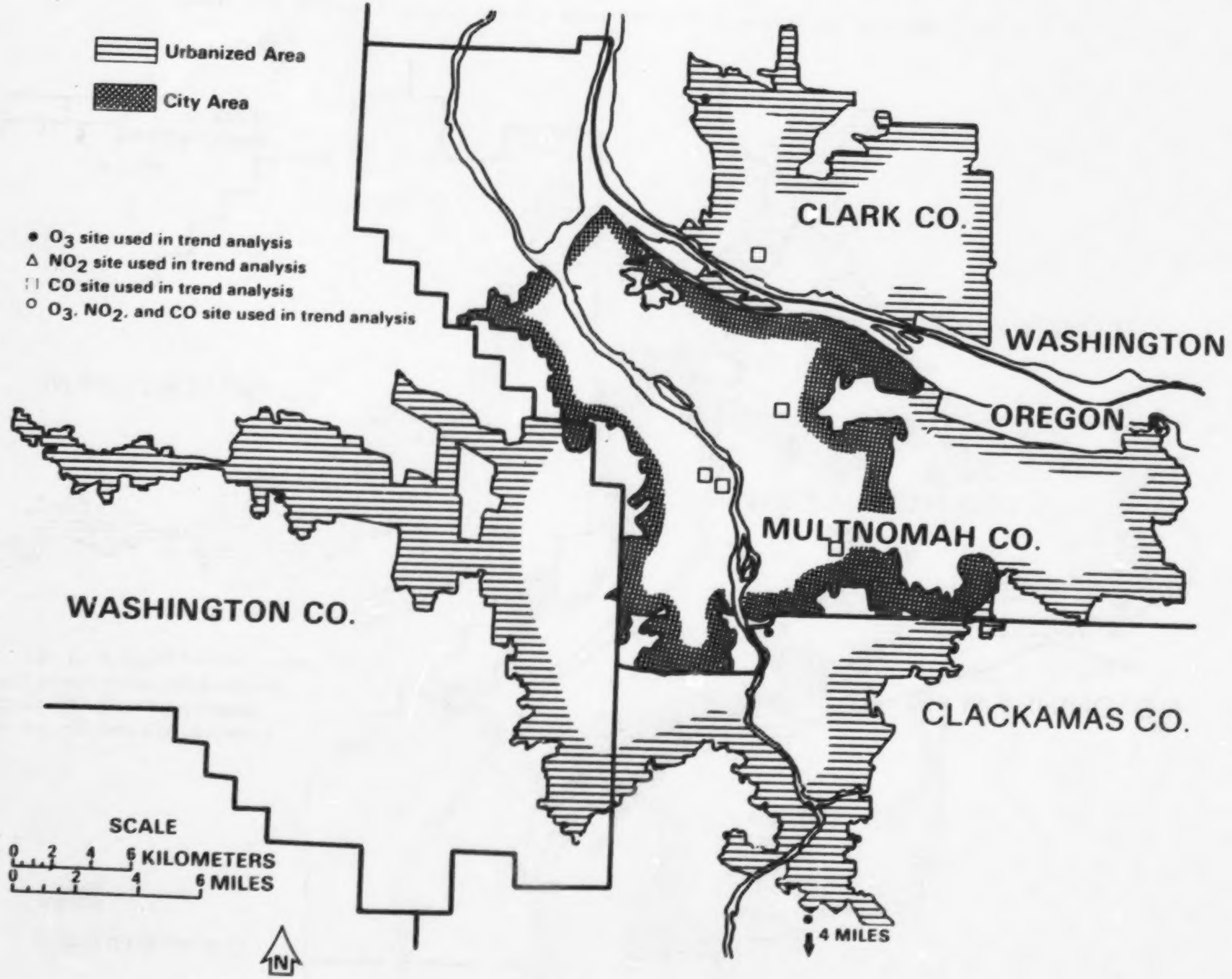

Urbanized Area
City Area
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
CLARK CO.
WASHINGTON
OREGON
MULTNOMAH CO.
WASHINGTON CO.
CLACKAMAS CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
N
4 MILES

Figure 5 39 Location of O_3, NO_2, and CO Monitoring Sites in Portland, OR WA 1981 1985

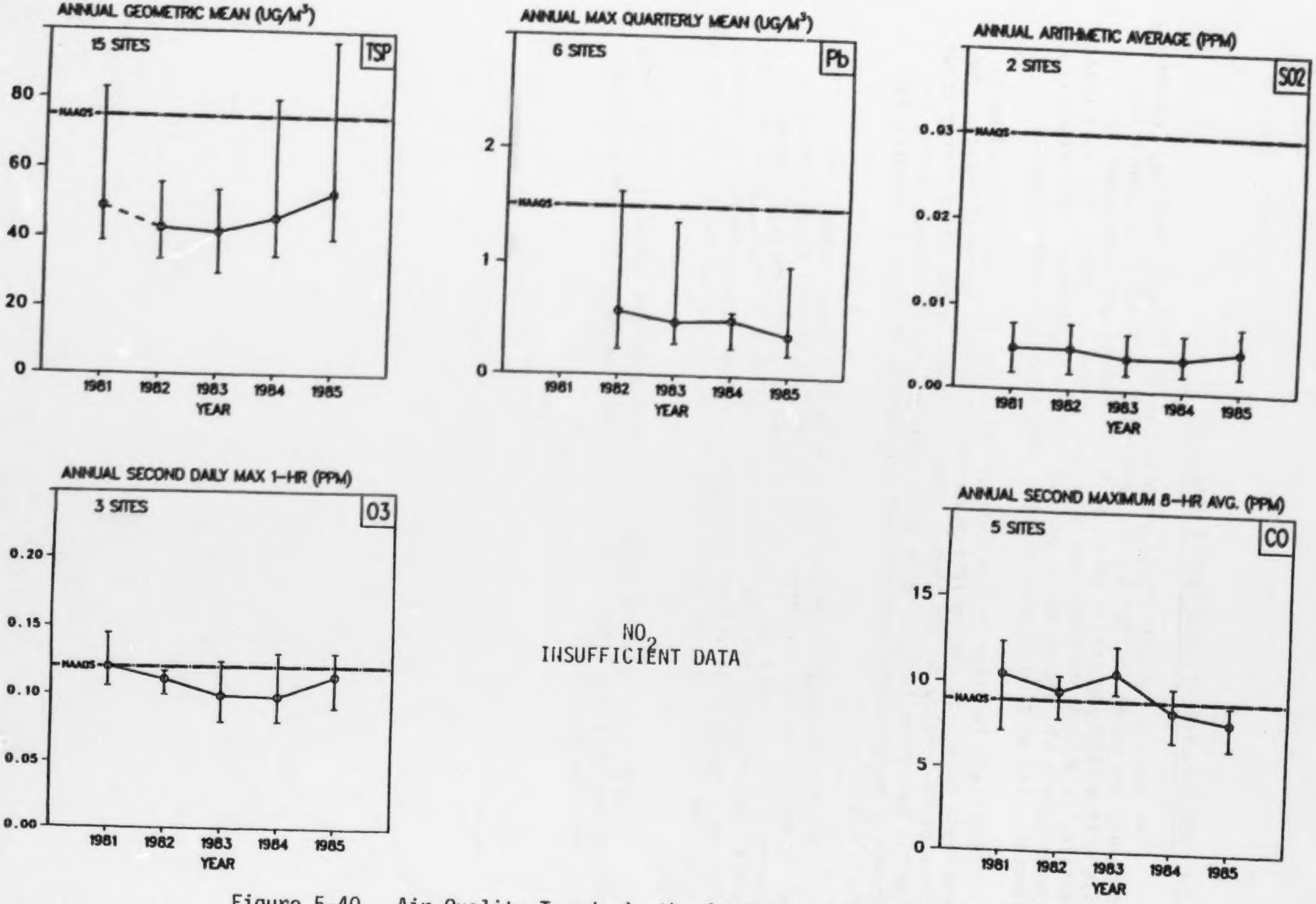


Figure 5-40. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Portland, OR-WA Urbanized Area, 1981-1985.

5.14 SEATTLE-EVERETT, WASHINGTON URBANIZED AREA

The Seattle-Everett urbanized area, which includes Seattle, Everett, Bellevue, and other smaller towns, ranks 20th nationally in population size with a 1980 population of 1,391,535. Tacoma, while adjacent to Seattle, is a separate urbanized area and is not included. The area covers approximately 410 square miles and most of the population (approximately 85 percent) live in King county with the remainder in Snohomish county.

Seattle's location on the side of the Puget Sound with a good harbor and ready access to the Pacific ocean made the city an ideal location for commerce to develop in the timber trades. Based on the early timber trade, Seattle has grown to be a major port city in foreign trade, leading to growth in manufactured products and development of other transportation facilities.

Seattle is located inland from the Pacific Ocean between 100 to 150 miles and surrounded on three sides by the Cascade and Olympic mountain ranges which moderate the Pacific maritime and continental climates. The sheltering from the climates to the east and west of the mountain ranges provide a rather mild winter and summer. Annual precipitation is approximately 34 inches, most of which falls during the period between October and March.

Figures 5-41 and 5-42 show the locations of the monitors used in the trends analyses and Figure 5-43 depicts the trends for all the pollutants in the urbanized area.

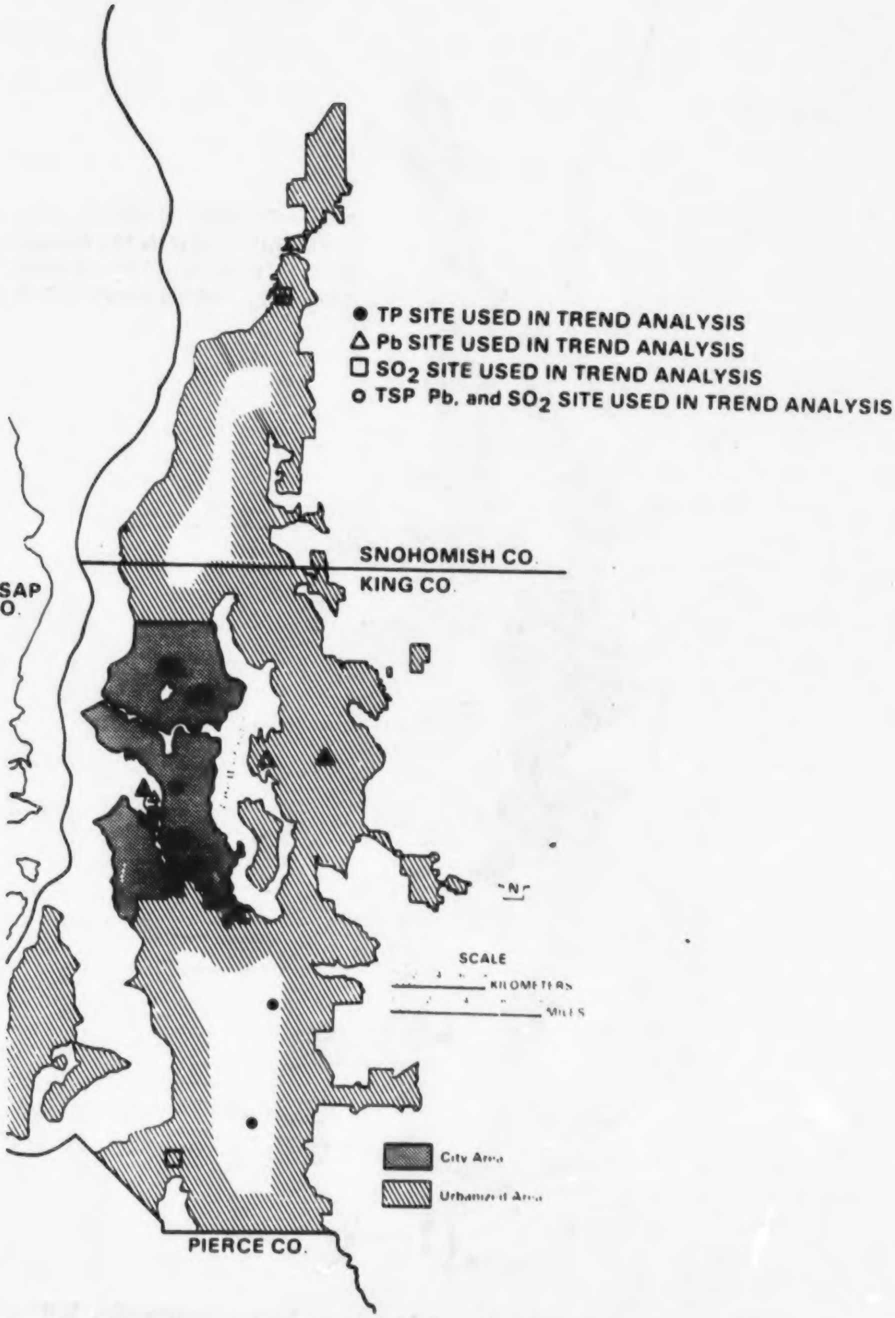

● TP SITE USED IN TREND ANALYSIS
△ Pb SITE USED IN TREND ANALYSIS
☐ SO_2 SITE USED IN TREND ANALYSIS
○ TSP Pb, and SO_2 SITE USED IN TREND ANALYSIS
SNOHOMISH CO.
KING CO.
KITSAP CO.
N
SCALE
KILOMETERS
MILES
City Area
Urbanized Area
PIERCE CO.

Figure 5-41 Location of TSP, Pb, and SO_2 Monitoring Sites in Seattle WA 1981-1985

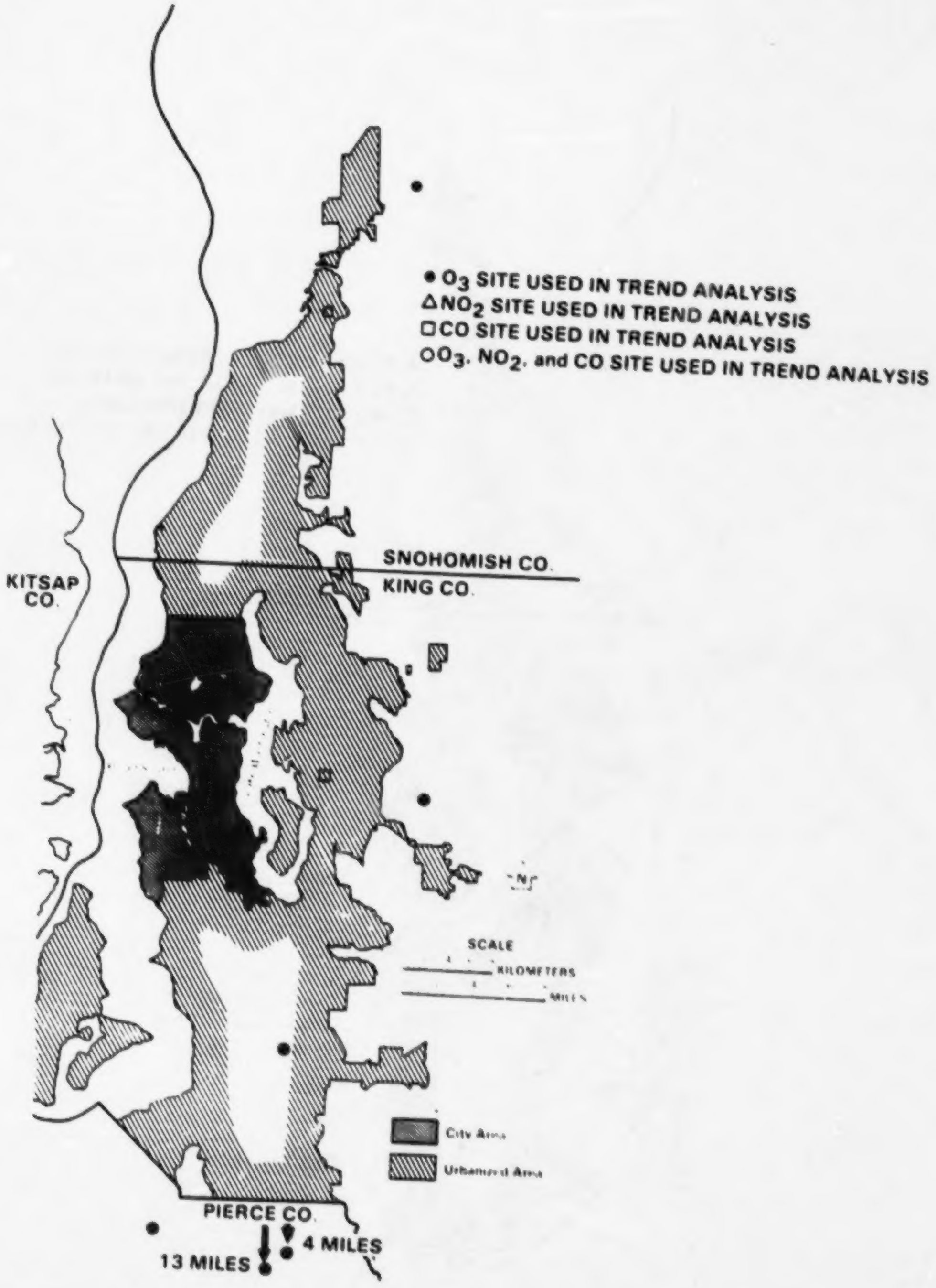

● O_3 SITE USED IN TREND ANALYSIS
△ NO_2 SITE USED IN TREND ANALYSIS
□ CO SITE USED IN TREND ANALYSIS
○ O_3, NO_2, and CO SITE USED IN TREND ANALYSIS
SNOHOMISH CO.
KING CO.
KITSAP CO.
SCALE
KILOMETERS
MILES
City Area
Urbanized Area
PIERCE CO.
4 MILES
13 MILES

Figure 5-42. Location of O_3, NO_2, and CO Monitoring Sites in Seattle, WA 1981-1985

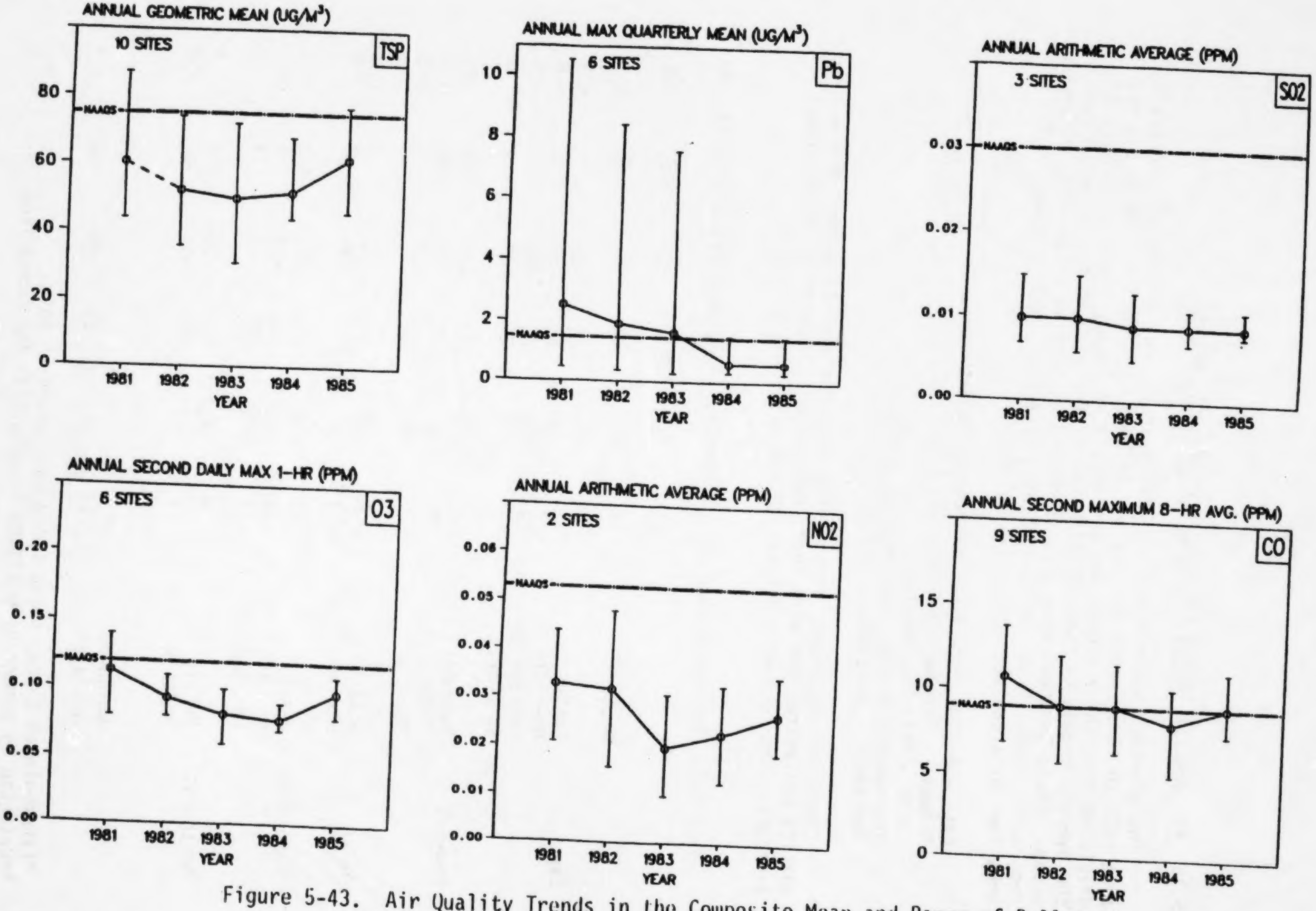


Figure 5-43. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Seattle, WA Urbanized Area, 1981-1985.

5.15 AIR QUALITY TRENDS FOR FIVE GEOGRAPHICAL AREAS

The previous subsections included year to year individual urbanized area 1981 to 1985 trends for the six criteria pollutants. Table 5-2 was developed from these trends and presents a pollutant specific summary of the overall change in concentration levels for each of the 14 urbanized areas. These 14 areas were grouped according to five arbitrarily arranged geographic areas: East, Midwest, South, Southwest, and Northwest. The breakdown by urbanized area is as follows:

East - Boston, New York, Baltimore, Philadelphia
Midwest - Chicago, Detroit, St. Louis
South - Atlanta, Houston
Southwest - Denver, Los Angeles, Phoenix
Northwest - Portland, Seattle

Composite geographic area averages of the overall 5-year change in air quality concentrations were then prepared and compared to the national averages. The following discussion addresses these findings.

Table 5-2. Percent Change In Air Quality Trend Statistics 1981 To 1985

		TSP	Pb	SO_2	CO	NO_2	O_3
	National	-18	-49	-15	-17	- 5	- 3
East	Boston	- 6	-54*	-26	-23	0	+33
	New York	- 9	-64*	-16	-18	+ 1	- 8
	Philadelphia	-19	+ 6	-21	-29	- 2	- 5
	Baltimore	-13	-53	-26	-20	+ 9	- 5
Midwest	Detroit	-15	-60	-27	-24	-16*	-24
	Chicago	-25	-56	-18	-35	-23	+ 4
	St. Louis	-27	-54*	+14	-24	- 9	+ 3
South	Atlanta	-17	-63	-	-33	-	- 4
	Houston	-33	-66	+16	-16	-22	- 3
Southwest	Denver	-10	-42	-31	-13	+ 3	-12
	Phoenix	-18	-63	-41	-32	-	- 6
	Los Angeles	-15	-65	-24	- 8	-14	0
Northwest	Portland	+ 8	-45*	0	-26	-	- 6
	Seattle	+ 2	-76	-10	-16	-18	-13
	Weighted Average**	-17	-50	-15	-20	-12	- 4

*Extrapolated 5-year trend based on 4 years of data.
**Weighted by number of monitors in each city for comparison to national average.

5.15.1 TSP TRENDS

Four of the five areas are compatible with the 18 percent national decrease in TSP, with the East and the Southwest averaging 12 percent and 14 percent decreases, respectively. On the other hand, the Midwest and the South exceeded the national percentage decrease with values of 22 percent and 25 percent, respectively. The Northwest Region had increases in TSP of 2 percent in Seattle and 8 percent in Portland over the same 5-year period. All of the overall increases occurred because of higher TSP levels in 1985. The winter of 1985 was the coldest on record in the Pacific Northwest with a 17 percent increase in heating degree days over 1984. Also 1985 was the dryest year in a century with a 35 percent decrease over 1984 in the number of hours with precipitation. The abnormally cold year led to increased wood burning and road sanding. In Portland, there was also a 2.5 percent increase in average daily traffic volume. The Northwest also had a generally higher level of economic growth than in past years. All these factors tend to re-enforce the higher levels of TSP recorded in 1985 in the Pacific Northwest.

5.15.2 Pb TRENDS

The similarities between the magnitude of the decreases in lead concentrations in all the large urbanized areas across all geographic divisions is remarkable. Boston, New York, St. Louis, and Portland had 4 years of relatively complete data and the 5-year trend is based on extrapolating the 4-year trend to a fifth year. With the exception of Philadelphia, which had a 6 percent increase, most of the rest of the urbanized areas had decreases in the 50 to 60 percent range. The East had the lowest decrease with 41 percent, the Midwest, South, Southwest, and Northwest experienced average decreases of 57, 65, 57, and 60 percent, respectively compared to the national average of 49 percent. The higher levels and large decrease in Seattle (76 percent) were driven by one site located across the street from a lead point source which discontinued operations in 1984. There is another lead site about 0.4 miles away on the other side of the source which does not show similar elevated values. If the source oriented site is not used, the 5-year trend in Seattle reduces to 53 percent. In Philadelphia, the composite Pb average concentration increased 6 percent from 1981 to 1985 compared to the national decrease of 49 percent. This upward trend is attributed to a source oriented Pb sampler which is located near a plant which manufactures lead oxide pigment for paint. The seven traffic oriented sites show an average decrease from 1981 to 1985 of 13 percent. This decrease which is considerably less than the national trend of 49 percent is attributed to one site which showed an 80 percent increase from 1982 to 1985. This site is downwind of a major interstate highway and major construction during this period has occurred around the site. It is speculated that re-entrained dust containing deposited Pb particles are the major cause of the increased levels of this site. As stated earlier in the report, between 1984 and 1985, the emissions of lead nationally were reduced by 48 percent. This reduction was a combination of a drop in the lead allowed in gasoline and an increase in unleaded gasoline sales. This drop [illegible]ssions was accompanied by a 32 percent decrease in ambient lead leve[illegible] nationally and a 34 percent average decrease in lead levels within the 14 city subset between 1984 and 1985. The range of the decreases within the 14 cities was between 1.6 percent in Seattle to 53 percent in Atlanta.

5.15.3 SO_2 TRENDS

The composite average of the five individual geographic areas showed an 11 percent decrease compared to a 15 percent decrease in the national average. The East and Midwest had a 22 and a 10 percent decrease, respectively. The Southwest exceeded the national trend with an average decrease of 32 percent while the Northwest had a substantially lower decrease of 5 percent. The high decrease in the Southwest for the 1981 - 1985 time period was driven by the one site in Phoenix which recorded a 41 percent decrease for that area. Although the values in the Southwest are among the lowest in the county, the large percent decrease is believed to come from a general lowering of SO_2 background levels due to the reduction of emissions from the smelting industry in the Southwest over the last 5 years.

The Northwest had only a modest 5 percent decrease with no change at all recorded over the last 5 years in Portland. The SO_2 levels from Portland however are the lowest in the 14 cities analyzed and tend to fluctuate around the minimal detectable levels of the instruments. The only urbanized areas in which there was an increasing trend were St. Louis and Houston. The 14 percent increase in St. Louis is attributable to an economic upturn in the early 1980's and continuing at least through 1984. Although the SO_2 levels in Houston are among the lowest of the 14 cities in the analysis, the 16 percent increase is believed to be a result of the general conversion of industrial boilers in the city from natural gases to fuel oil over the last few years.

5.15.4 CO TRENDS

Similar to the other pollutant primarily attributable to motor vehicle emissions (lead), the trends in CO are remarkably uniform within a geographic area when compared to the national average. The East, Midwest, South, Southwest, and Northwest areas decreased by 23, 28, 24, 17 and 21 percent, respectively. The overall five area composite decrease of 20 percent is close to the national composite average decrease of 17 percent.

Upon closer inspection of the figures, it is apparent that for most cities a good share of the 5-year decrease was caused by the decrease between 1984 and 1985. Although some cities showed an increase from 1984 to 1985, the average decrease of all 14 cities was 12.3 percent. The range of change was from +23 percent in Los Angeles to -34 percent in Baltimore. This compares with the already noted national composite average decrease between 1984 and 1985 of 10 percent. Also it is of interest to note that for the first time six major urbanized areas had no measured violations of the CO NAAQS at the sites used in this trends analyses. Since the national CO emissions only dropped 3 percent between 1984 and 1985, the improvement is believed to possibly be a combination of meteorological conditions, localized control measures, the change in the vehicle mix, traffic patterns, and vehicle miles traveled in the vicinity of the monitors.

5.15.5 NO_2 TRENDS

Data for the NO_2 trends analyses were the most sparse of all. The one Phoenix NO_2 site showed an 81 percent increase if 1981 to 1985 data were used and a 35 percent decrease if 1982 to 1985 data were used. As a result it was decided not to use the Phoenix NO_2 data in the regional area NO_2 analyses. The urbanized areas of Atlanta and Portland had no sites which met the trend criteria. The remaining 11 areas yielded the following area trends.

In the East, the composite average was a 2 percent increase with Baltimore measuring the highest increase (9 percent) over the 1981 to 1985 time period. The other areas all showed a higher decrease than the national average of 5 percent with a 16 percent decrease in the Midwest, a 22 percent decrease in the South (Houston only), a 6 percent decrease in the Southwest and an 18 percent decrease in the Northwest (Seattle only). There is no readily discernible reason as to why the NO_2 concentrations in Baltimore increased 9 percent from 1981 to 1985.

5.15.6 O_3 TRENDS

The average decrease of the five geographic areas is 4 percent which is almost identical to the national average of 3 percent. The East shows an increase in O_3 of 4 percent while the rest of the areas show decreases. The Midwest, South, Southwest and Northwest show decreases of 7, 4, 6 and 10 percent, respectively. Upon closer examination two cities stand out, Detroit and Boston, which drive the averages for the respective geographic region. The 24 percent improvement in Detroit can be explained by summertime meteorology in 1984 and 1985 which was conducive to the suppression of O_3 levels. Almost all of the 24 percent decrease occurred between 1983 and 1984. The trend in Boston, based on only two sites, is driven by unusally low values in 1981. Using 1981 to 1985 data the increase is 33 percent; using 1982 to 1985 data the increase is only 8 percent; and using 1983 to 1985 data the trend decreases by 15 percent.

5.16 REFERENCES

1. 1980 Census of Population, U. S. Bureau of Census, PC 80-1, U. S. Government Printing Office, Washington, DC. December 1981.
2. Frank, N. H., "Nationwide Trends in Total Suspended Particulate Matter and Associated Changes in the Measurement Process," Proceedings of the APCA/ASQC Specialty Conference, "Quality Assurance in Air Pollution Measurement," Boulder, CO. October 1984.